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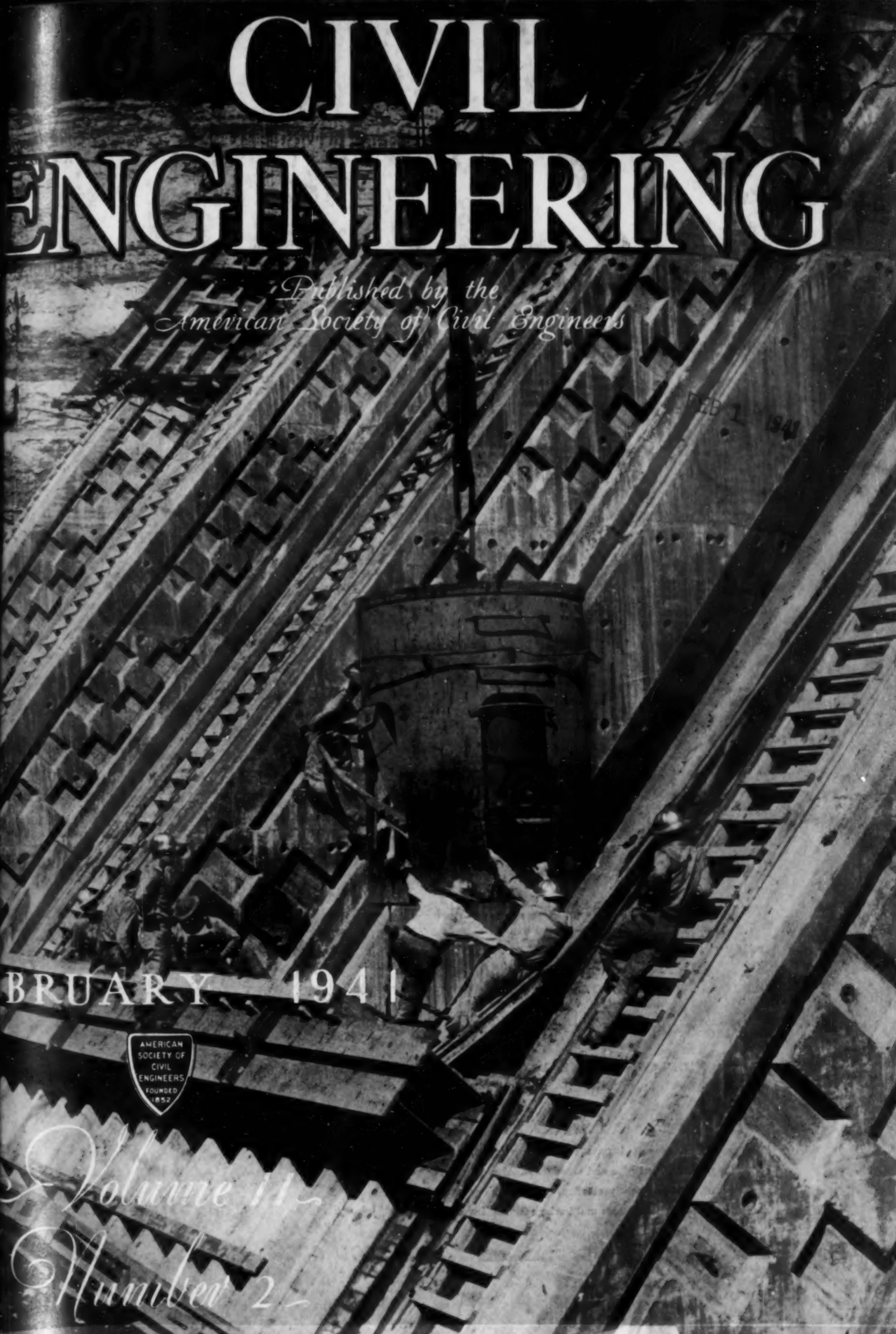

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

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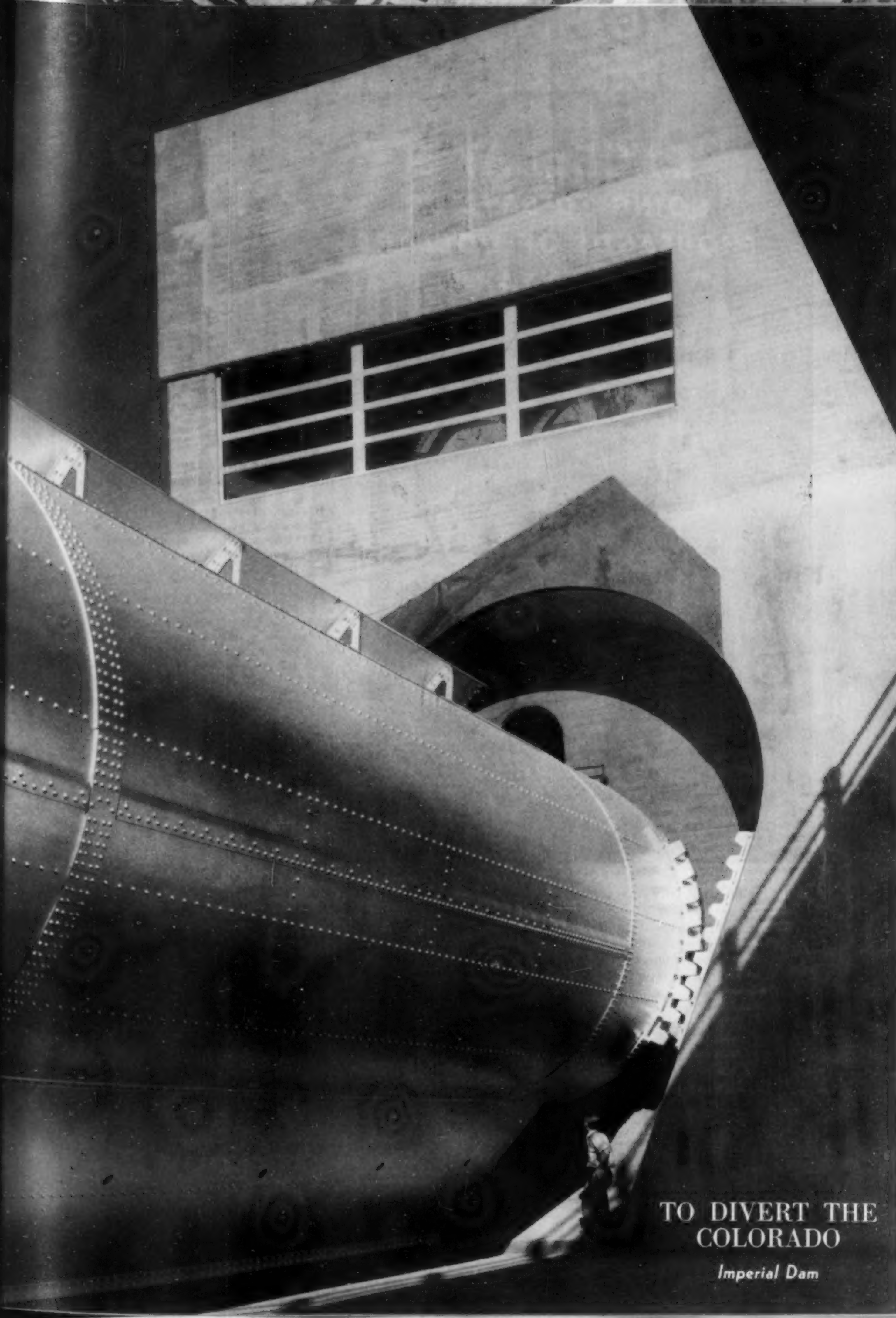

TO DIVERT THE COLORADO

Imperial Dam

Among Our Writers

SAMUEL B. MORRIS (Stanford, '11) was for 22 years chief engineer of the Pasadena Water Department. This experience culminated in the conception, design, and construction of the 328-ft high Morris Dam on the San Gabriel River. He returned to Stanford in 1935 where he has held his present position since 1936. He is water consultant to the National Resources Planning Board and Regional Adviser on Engineering Defense Training.

J. K. KNOERLE (U. of Mich., B.S. '19, M.S. '21) spent 4 years with the Missouri State Highway Commission, 2 with American Bridge Co., and 1 with Turner Construction Co. before going to J. E. Greiner Co. in 1928. With that firm he has been project engineer on numerous bridges and on the Pennsylvania Turnpike, and designing engineer in charge of other bridge projects.

E. B. DEBLER joined the U.S. Bureau of Reclamation in 1918 after a varied engineering experience. Since 1922 he has been in charge of project investigations concerned with problems of hydraulic capacities, power possibilities, and economic considerations.

HOMER M. HADLEY (U. of Wash.) for 25 years has been engaged in various aspects of concrete design. In 1918 he designed for the concrete ship section of the Emergency Fleet Corp. Regional structural engineer for the Portland Cement Assoc. since 1929, he has covered the Pacific Coast and the earthquakes at Tokyo, Santa Barbara, and Long Beach.

WARREN E. WILSON (Lehigh, '28; Ph.D., U. of Iowa, '40) has taught civil engineering at South Dakota School of Mines, Tulane University, and Wayne University during the period 1935 to 1940. In addition to the degrees cited, he holds an M.C.E. from Cornell and an M.S. from Calif. Inst. of Tech. He entered upon his present work in Sept. 1940.

CHARLES P. WILLIAMS (U. of Mo., 1890) served 20 years with the U.S. Bureau of Reclamation before going into private consulting work in California, Arizona, and Texas. He was consultant on Mexican irrigation developments for the J. G. White Corp. in 1927 and for the Mexican National Commission of Irrigation in connection with the Rodriguez Dam and other work from 1928 to 1937. He has been with Ambursen since 1938.

GEORGE R. RICH (Worcester P.I., 1919) has worked with Stone and Webster on the Conowingo, Osage, and Rock Island hydroelectric developments; with the Corps of Engineers on the Cape Cod Ship Canal, the Fort Peck and Passamaquoddy hydroelectric projects, and the Flood Control Plan for the New England Rivers. He has held his present position since 1937. ROSS M. RIEGEL (Cornell, 1904) has been designing engineer of the Miami Conservancy District, engineer for the Emergency Fleet Corp., hydraulic engineer for the West Penn Power Co., and bridge engineer for the City of Pittsburgh. His current position dates from 1934.

J. B. LIPPINCOTT went to Southern California in 1892 for the U.S. Geological Survey. His work has been almost continuously devoted to various phases of water conservation and use from California to Alaska, Mexico, and the Hawaiian Islands. He initiated stream gagings in California and Arizona, was supervising engineer for the Reclamation Service on the early Colorado River work, and assistant chief engineer on the building of the Los Angeles Aqueduct. He is now engaged in national defense work.

C. A. HOLDEN (Columbia U., C.E., '03) now engaged on the design of a TNT manufacturing plant, was for 18 years the principal assistant of Gavin Hadden, civil engineer, formerly of New York, on work largely concerned with the design of facilities for physical training and related seating structures.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Diagnosing Engineering Education

By Samuel B. Morris

Member American Society of Civil Engineers
1940 Chairman of the Society's Committee on Engineering Education

NATIONAL security is the order of the day and the engineer is its administrator through his power of coordinating industry. So much in demand has he become that accelerated short courses in engineering have had to be established under government authorization to help meet the emergency. It is entirely proper, therefore, to reevaluate engineering education in terms not alone of present defense needs, but also of normal conditions—that is, of long-range usefulness.

The Question at Issue.~To put it specifically, how can engineering education be adjusted to better fit the graduate for the present and future requirements of industry, of professional engineering practice, and of society as a whole. On behalf of the Society's Committee on Engineering Education I wish to bring some of the conflicting views on this subject to the attention of practicing engineers in all fields and in all grades of responsibility.

The young engineering graduate has been accused of failure to recognize such factors as values and costs; of inadequate foundation in the basic sciences and mathematics; of inability to adequately express himself in written and oral English; and of insufficient familiarity with good literature and the humanities in general. What has happened is that the constantly expanding fields of engineering and technology have brought more and more specific technical courses. For years the colleges responded by adding units to the engineering curriculum until in almost every institution more units are required than in academic curricula.

Four-Year, or Longer, Courses?~With continued pressure for correction of the general deficiencies, there has come a strong feeling that engineering education should not be confined to the customary four years; or that a preliminary period of study in liberal arts is desirable before the student is admitted to the engineering school. At a number of institutions such cooperative combination courses have been provided. In fact, within the past year a bill was introduced in the New York State Legislature promoting this practice by giving credit for such educational experience to those applying for professional licensure.

By and large, the view of the older practicing engineer seems to be that the former limitation of four years on the engineering curriculum is still applicable to the needs of today.

Views of the Teaching Profession.~Within the past year a representative committee from the Society for the Promotion of Engineering Education has carefully appraised the whole broad field of the engineering college. While practicing engineers were consulted in the preparation of this report, it expresses primarily, I believe, the views of engineering educators, including many of those most prominent today.

The committee finds that the activities of engineers have a common denominator in the engineering method but are too numerous and varied to meet any legal definition of a profession such as law or medicine. And thus it coins the expression "the engineering fraternity" to envelop all those engaged in engineering work, including its many facets. The divergence of technical talents between the mechanical research engineer and the equipment sales engineer, it feels, is far greater than that between the mechanical engineer designer and the civil engineer designer. So there is frequently less difference between fields of engineering than functions of engineering. It is hardly feasible or desirable for engineering colleges to limit their purpose to the training of professional engineers.

Meeting a Deficiency.~Without question the present shortage of adequately trained and experienced engineers is being felt in many fields on account of the explosive expansion of national defense industries. To meet this situation the Engineering Defense Training program, under supervision of the U.S. Office of Education, is fostering many short-course engineering training programs in public and in tax-free private engineering schools. These courses include part-time, night-school, in-service classes in metropolitan areas or directly within industrial plants, as well as full-time day classes given at the colleges themselves. Tuition-free and generally running from 10 to 16 weeks, they are very specific courses geared to meet the particular and immediate problems of industry. They do not lead to a degree.

However, in spite of this apparent emphasis upon the definite, limited, and specific, there is a general feeling in the engineering schools and in industry that the full-time engineering graduate, broadly and fully trained, is the primary objective of the engineering course. The Engineering Defense Training program has recognized the paramount need for continuing the full-time programs. The short-course, more specialized type of instruction is necessary to meet the immediate expansion of industry. But how much of this program can be regarded as a temporary expedient?

Dedicated to Defense.—When the industrial capacity of the country has to be converted to the creation of implements of war to protect our democratic institutions from destruction by power-mad nations, the creative genius of engineers must be turned to national defense. No one desires this condition to continue. However, analysis of the international conditions and social forces rampant in the world leads inevitably to the conclusion that our wealth and energies will be directed toward arming for a decade or longer.

These are difficult times from which to look into the future. But it seems certain that our standards of living can only be maintained by developing our natural resources without defeat of conservation, and by continued increase in the efficient productivity of our industries. The great destruction wrought by this war will require even greater efforts toward reconstruction.

The present transfer of engineers from peacetime to defense activities, from industry to the army, cannot continue indefinitely. Recent history clearly demonstrates that the passing of peak defense activities, even if our country succeeds in keeping out of war, will present a very difficult economic and social problem—a problem that engineers should understand and help to solve.

And Back to Peace.—When world peace comes—and come it must—the problem of adjustment will require the highest service of engineers. There will be much physical reconstruction of war-torn Europe and Asia. Public work partially held in abeyance by war conditions will have to be resumed. Plans for such resumption should be made and kept continually up to date in anticipation of the longed-for day of peace. Planning for peace is less romantic and more difficult to stimulate than preparation for "M-day." Such planning need not, and must not, be suspended during time of war; failure to do so may be almost as disastrous as failure in preparedness.

Those who saw the General Motors Futurama at New York's World's Fair were thrilled by its prophecy of highways, transportation designed for speed with safety, and new types of cities. The engineer of tomorrow must have vision to plan this "World of Tomorrow." He must be skilled in commanding the forces and materials of nature in order to make them serve humanity more completely and economically.

Doesn't this new world indicate that there will be an increasing demand for men with an engineering background? For men broadly trained in the basic sciences, and for technologists to make the forces and materials of nature perform greater service to mankind?

Some Non-Technical Needs.—And the ever-increasing social-economic problem requires that the engineer should have understanding in this field also. Certain it is that the turmoil in which the world now finds itself will continue for a long time. The engineer is greatly affected by these social-economic-political forces and must work with them rather than against them, as he does with the forces of nature. It is not expected that college training in the humanities—at most hardly a year in all—will make engineers expert in these subjects. It should, however, open their minds for further study of the complex problems in the social sciences. And perhaps there may be some contributions by engineers, trained in quantitative thinking, toward the solution of these problems.

While no engineer will question the need for an adequate foundation in the physical sciences, yet all too often civil engineering curricula have been devoid of such basic subjects as thermodynamics, heat exchange, fundamentals of electrical engineering, physical metallurgy, and geology. Obviously a broad curriculum built upon the recommendations of the Committee on Aims and Scope of Engineering Curricula cannot go as far in engineering application as one that offers little or none of the social-economic stem, including business law and accounting. Even breadth of training in the physical sciences and common fundamentals of all engineering must detract somewhat from the desired technical specialization. In line with the S.P.E.E. recommendations, I have presented elsewhere in this issue [page 123] "A Proposed Undergraduate Civil Engineering Curriculum" for general discussion, as an aid to the Society's Committee on Engineering Education in its study of these problems.

Many Strings to His Bow.—A student broadly trained is better equipped to meet the shifting demands for engineers—and these demands may shift very rapidly during such periods as the present, with its emphasis on national defense. But there are always major shifts when an industry is born through some new invention, expands, and finally becomes stable, or recedes. We have watched the changing demand for engineers by the railroad, automobile, marine, oil, and chemical industries. The marine engineer and naval architect have been faced with either a feast or a famine, while the broadly trained mechanical or civil engineer has been in rather constant demand.

Of course there is always a need for enlarging and deepening knowledge in a relatively narrow field—that is, there is always need for specialists. These men will have to secure their specialized training by further graduate research or study. In metropolitan areas, for example, more and more advanced specialized training is being secured by students as after-hour study.

Broader training in the scientific-technological and the humanistic-social fields will ensure more adequately educated engineers for professional practice. It will, at the same time, offer a means of better equipping the considerable and growing number of students who desire an engineering foundation upon which to build a business or other non-technical career. Those of us in engineering education believe that such a training better fits its graduates for business and life than does the ordinary arts course, which lacks purpose and coordination. Above all, a student should be trained to think and reason for himself and thus to meet the changing problems in a changing world.

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Double Swing Bridge Embodies Unique Details

Two 140-Ft Through-Girder Spans Centered on Concrete Pile Clusters Are So Delicately Balanced They Can Be Rotated by Hand

By J. K. KNOERLE
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PROJECT ENGINEER, THE J. E. GREINER COMPANY, BALTIMORE, MD.

EXTREMELY shallow girders and low clearances for operating equipment made ingenuity in design a necessity on the Coinjock Bridge. The type adopted has seldom been used in this country, and the applications of modern locking and turning machinery, silicon steel members, and central lubricating system are believed to be new. The details Mr. Knoerle describes show thorough attention to safety, economy, and reliability.

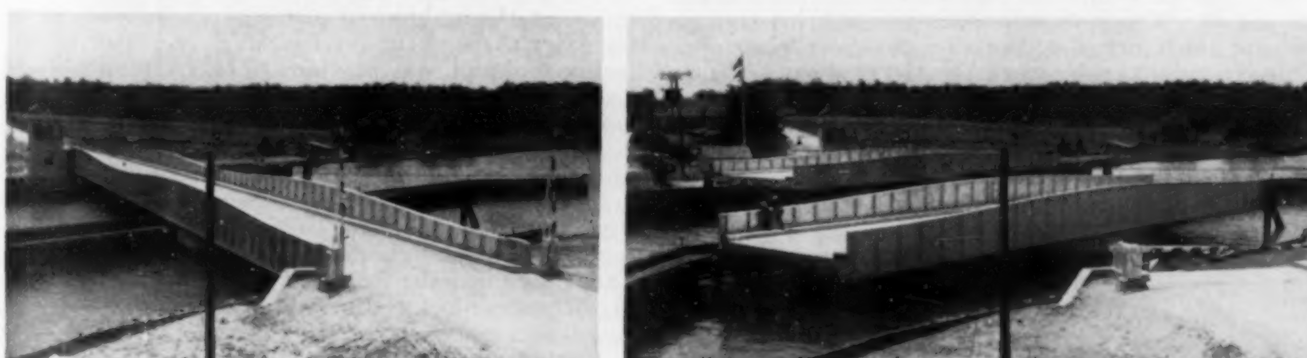
THE Inland Waterway from Norfolk, Va., to Beaufort, N.C., connects Currituck and Albemarle sounds and is crossed by State Highway No. 34 at Coinjock Post Office. This highway extends eastward from this point to form the only connection to the Kitty Hawk section of the coast of North Carolina. Up to this year the canal crossing consisted of a narrow two-lane, single-leaf bascule span with an overhead counterweight. The bridge crossed the canal at right angles, but sharp dangerous curves connected it with the approach roads on each side.

About two years ago the State of North Carolina, in cooperation with the District Engineer, U.S. Engineer Office, Norfolk, Va., under whose jurisdiction the bridge is operated, proposed to eliminate these curves with a long tangent across the canal. Such a plan made necessary the construction of new connecting roads and a new bridge. Because of the 55° skew, the new bridge would be much longer than the old one.

The preliminary report covered designs, plans, and estimates of cost for four different types of movable bridges: (1) a double swing bridge with symmetrical leaves, (2) a double swing bridge with unsymmetrical leaves, (3) a vertical-lift bridge, and (4) a double-leaf bascule bridge.

A double swing bridge of the through girder type with symmetrical leaves seemed to fit the skew requirements. It could also be made to fit the required underclearance of 6.52 ft and at the same time meet the approach grades with long vertical curves. Because of the skew angle and small angle of opening, it could be quickly rotated with a minimum of movement. The type also provided the shortest distance center to center of bearings because of the design of the circular piers. Probably the most important feature was the economy effected because the rear or shore half of each swing span would serve as an approach span as well as a counterweight for the cantilever half of the bridge extending over the canal. A saving was also effected in pier, counterweight, and superstructure design, and power and machinery requirements were less than for the other types. Owing to the low elevation of the bridge, wind forces on the piers were low. The estimate of cost for the double swing bridge with symmetrical leaves was $135,000.

A double swing bridge with unsymmetrical leaves was likewise considered because of appearance and lack of interference with the old bridge and waterway traffic during erection, and because it also fitted the requirements of skew, grades, and clearances. On the other hand, it required separate approach spans between the



THE COINJOCK BRIDGE—NORTH SPAN IN FOREGROUND
Roadway Is 24 Ft Wide Between 2-Ft Sidewalks

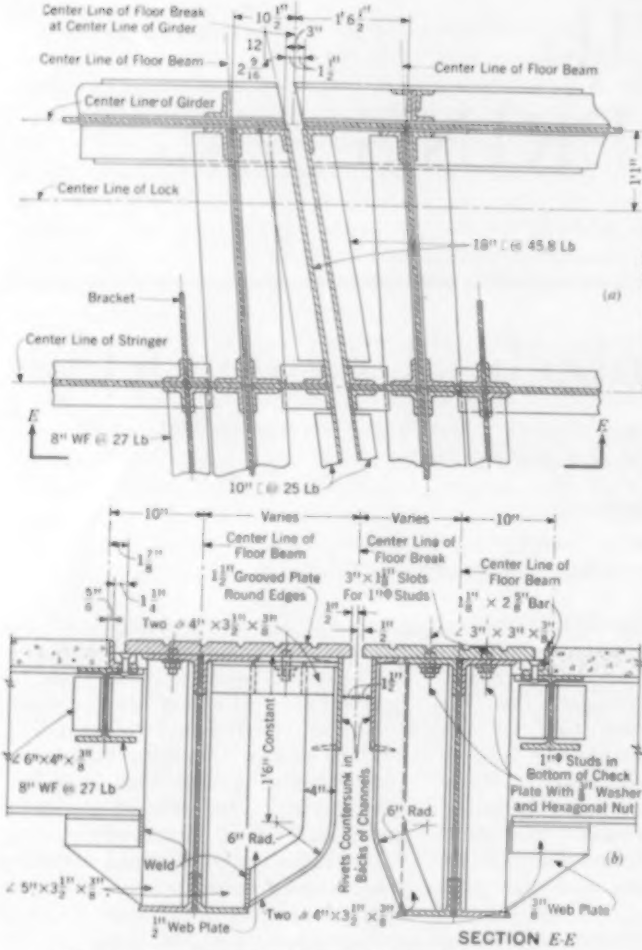
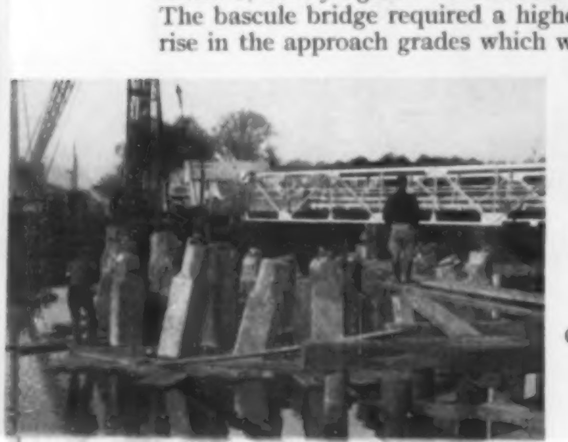


FIG. 1. CONSTRUCTION OF THE CENTER FLOOR BREAK
(a) Plan, (b) Typical Section E-E

ends of the counterweights and the abutments, and also called for very heavy counterweights and complicated locking and anchoring devices. Moreover, the large overturning moment caused by the live load on the cantilever arm extending over the channel would have made necessary very heavy piers and extra piles and anchorages. The estimate for this type therefore had to be placed at approximately $153,000.

A vertical lift bridge was next considered, but the skew crossing and the 82-ft vertical clearance made this design expensive. Foundations and piers were not economical because of the size and depth required to take care of the high wind forces on the elevated portions of the structure. The lift span, of through truss design, had a length of 144 ft. The approach spans consisted of through girders which formed supports for the tower backstays. The vertical lift bridge was estimated at about $157,000.

A double-leaf deck bascule span was considered because of its better appearance, lower operating cost, and high factor of safety against vehicles crashing into the canal. The bascule bridge required a higher grade line, with a rise in the approach grades which was objectionable because of the adjacent buildings. The low elevation of the bridge would also cause the counterweight to be submerged when the bridge was raised. This would necessitate deep hollow piers for counterweight pits. These piers would be rectangular, and because of the skew crossing, would extend back from the fenders on the bridge center line, and would increase the center-to-center distance between bearings to 148 ft. This type also required short approach spans. The double-leaf bascule was estimated at $170,000 and was the most expensive of all the types considered.



CONCRETE PILES IN PIVOT PIER CLUSTER
Inclined Members Resist Horizontal Forces and Torsional Moments

A decision having been rendered in favor of the first double swing type, plans were immediately prepared and a contract for the bridge was let in July 1939.

Low vertical clearances required the use of through girder design. The piers were supported on piles that were definitely limited in number; therefore all dead weights had to be held to a minimum. A roadway elevation of 9.54 above mean low water at the fender line and a girder underclearance of 6.52 ft resulted in a very small space for the floor beams and deck, machinery supports, and machinery. Shallow depths for the main girders and floor beams also resulted. Silicon steel was used for all main girder material, floor beams, and pivot diaphragms. The high L/D ratio of all sections induced serious consideration of the effects of excessive deflections.

LOADS AND DEFLECTIONS

The total maximum deflection of the girders at the center shear lock was figured at 3 in., with the lock driven and the two spans acting together. For maximum deflection, the two cantilever arms were considered uniformly loaded for their full length with a concentrated load placed at the center floor break. It was thought that this large deflection would produce vibrations that might be noticeable to traffic, but these did not develop when the bridge was placed in operation.

The bridge is designed for H-15 loading and also for an additional future wearing surface weighing 15 lb per sq ft. In order to reduce the dead load, a floor of light-weight steel grid decking filled flush with concrete was adopted. The double center floor beams of the main pivot girders were quite heavy on account of their shallow depth. Cover plates were eliminated in order that their top flanges might be shaped to the crown of the roadway and welded directly to the floor.

Considered in the girder design were the following cases: (1) live load on the anchor arms, (2) dead load, and (3) live load on the cantilever arms. Seventy per cent of the dead load was assumed effective in counteracting live load of opposite sign when the dead load was smaller.

Steel details at the center and rear floor breaks required much study. At the center floor break the opening is in the shape of a reverse curve consisting of two circular curves each having its center at one of the pivots. For this joint $1^1/_2$-in. grooved plates were used and cut to the exact shape of the reverse curve. A horizontal adjustment of 2 in. was provided to take care of erection discrepancies, inaccuracies in fabrication, temperature movements, or possible future pier movements.

The girder anchorage at the abutments was formed by extending the bottom flanges of the girders to form brackets which slide under anchorages on the abutments when the bridge is closed. The end floor beams at the center floor break were made extra heavy to transfer the loads from the center shear lock to the main girders (Fig. 1). The shear-lock castings are supported between these floor beams and 18-in., 45.8-lb channels.

A light load and large rack radius permitted the use of only one driving pinion in conjunction with the turning machinery. Because of the small angle of opening, the rack subtended an angle of only 66°. An internal gear

rack was used to provide the maximum radius possible. Only a 10-hp turning motor was required. Such small power requirements and the small space available for machinery made it possible to use a right-angle speed reducer to transmit the motor power to the rack. A commercial type was found which had the designed gear ratio and which would also fit into the small space. This was equipped with special alloy gears for the heavy-duty service imposed by the movable bridge specifications. The diameter of the low-speed shaft which held the pinion had to be increased and the shaft was equipped with heavier bearings to take the overhung load on the pinion. The reducer was equipped with its own oil pump to lubricate its own bearings. For hand operation the intermediate gear shaft was extended through the top of the gear box where it could be connected with a capstan. The use of a speed reducer eliminated the open gear trains and exposed bearings commonly found on movable bridges.

Difficulty was experienced in transferring the torque and kick-out load of the pinion through the gear box and connecting bolts to the bridge proper. Supports had to be heavy enough to prevent these loads from deflecting the gear box and causing excess pinion wear. A heavy cradle was therefore developed to hold the speed reducer. It consisted of heavy side channels with a solid plate floor. This cradle in turn was braced in all directions to the floor beams, stringers, and main girders. The 10-hp turning motor is totally enclosed and furnished with a motor-driven brake. The speed reducer has a 91 to 1 ratio. The main pinion has 15 teeth with a 2.09-in. circular pitch and a 5-in. face.

SHIMS PROVIDE CLEARANCE AT BALANCE WHEELS

Balance wheels play an important part on a bridge of this type. These wheels must provide accurate control of the position of the anchor arm during closing operations to prevent the bridge from tipping. Eight wheels were used to provide many points of support. The track was adjusted to proper height on wedges in a slot on the pier and then grouted into place to insure its being perfectly level. By means of shims, $^1/_{16}$-in. clearance was provided between the wheels and the track. This small clearance was necessary to maintain a maximum $^3/_8$-in. movement at the anchorage during closing operations. As an additional precaution, the edges of the anchorages on the girder and the abutment were beveled, and are kept greased to facilitate closing.

The center shear lock, center wedges, latch, and end wedges are operated by a 5-hp motor through a 25-to-1 speed reducer (Fig. 2). The south span wedge motor is connected through a line shaft to three worm-gear speed reducers which operate the cross shafts. On the north span only two worm-gear speed reducers are required, as the operating mechanism of the center lock is on the south span. The center wedges are of conventional design but the end wedges have a double function to perform. Each span swings shut perfectly balanced and without any change in elevation of the girder ends when the bridge is locked. The bracket on the end of each anchor arm slides into place under the anchorage bracket, which is built into the abutment and designed for live-load uplift. When the end wedges are driven, these girder brackets are forced up tight against the abutment anchorages. Ample clearances and extra power were provided in order to prevent trouble from changes in temperature between the top and bottom girder flanges,

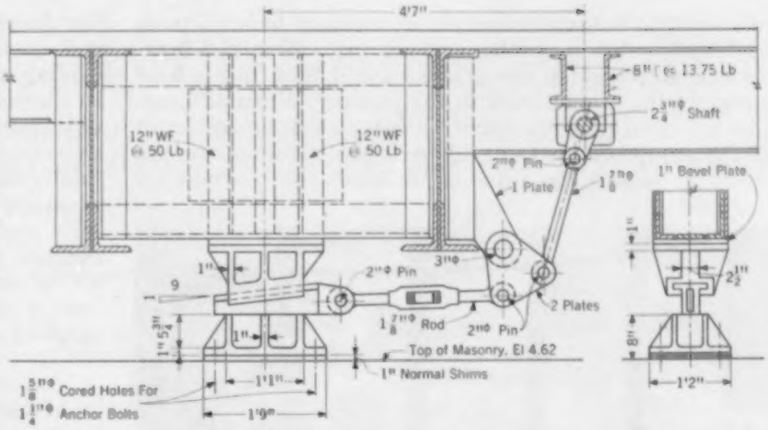


FIG. 2. WEDGE MECHANISM ON PIVOT PIER

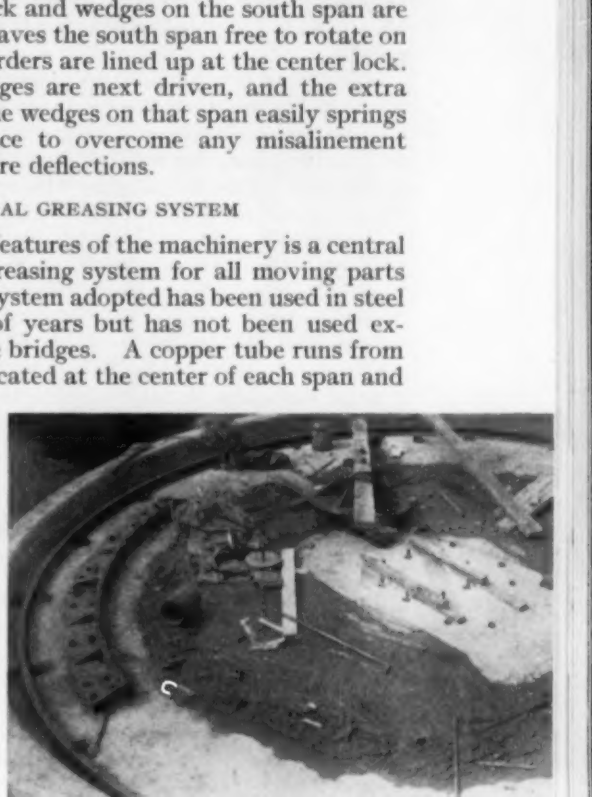
or changes in deflections from unbalanced conditions caused by snow or ice. Such deflection changes would cause the girders to drop or rise at the anchorages when the wedges were released or closed. Many other types of shear locks were studied, but they all were subject to loosening under temperature movement. In the case of the anchorage used, the wedge itself shifts horizontally with the girder during temperature changes and cannot become loosened. This prevents the end of the girder from slapping under traffic impact.

In addition to the conventional roller latch, wood bumpers have been provided at the abutments to prevent overdriving during closing. Air buffers attached to the bottom of the end floor beams retard the closing movement. These buffers are supplied with air valves to adjust the degree of retardation. Spring bumpers are placed on a group of piles to stop the bridge in its fully open position.

The center shear lock consists of two 4 by 6-in. steel bars supported in steel castings, which are made extra long to take the cantilever action on the shear bar, and which are provided with grease holes for adequate lubrication. The machine clearance between the bars and the castings is very small to prevent undue wear from impact under traffic. These center castings were very accurately alined to obtain smooth operation of the locks and to ensure a perfect fit of the roadway plates. The lock bars are operated on the toggle principle. In operating the bridge, the center lock and wedges on the south span are driven first. This leaves the south span free to rotate on its pivot while the girders are lined up at the center lock. The north-span wedges are next driven, and the extra power supplied for the wedges on that span easily springs the girders into place to overcome any misalinement caused by temperature deflections.

CENTRAL GREASING SYSTEM

One of the newer features of the machinery is a central manually operated greasing system for all moving parts and bearings. The system adopted has been used in steel mills for a number of years but has not been used extensively on movable bridges. A copper tube runs from the pressure pump located at the center of each span and connects through individual valves to each bearing. These valves have a sliding piston which meters an exact amount of grease for each bearing. Each



PIER TOP WITH RACK SEGMENT AND TRACK

valve in the line must operate in rotation before grease is allowed to flow on to the next bearing. Should a bearing become clogged, the grease cannot flow through to complete the circuit back to the pump. When all bearings are open and the circuit is completed, an indicator on the pump is actuated. There is also a counter on the pump to record the number of times the bearings are

CLEAR VIEW FROM CONTROL HOUSE WINDOW

Indicator Lights Show Position of Span, Wedges Driven or Released, and Gates Raised or Lowered

greased as a check on the operators. This greasing system should shortly pay for itself by the savings effected in reduced maintenance and repairs, and by the assurance of continuity of operation and fewer breakdowns.

CONTROLS AUTOMATIC FOR SPEED AND SAFETY

Because the bridge may be operated as many as 40 times daily, the electrical controls were made as automatic as possible. The photograph shows the metal control desk in the operator's house. All operations are interlocked to prevent opening before the safety gates are closed and wedges pulled, or to prevent raising the gates and driving the wedges before the bridge is closed. One pair of highway gates is placed near the abutments and a single gate is placed several hundred feet away across the oncoming lane. Flashing lights and warning bells are also provided at a distance of 200 ft from the bridge abutments.

The operator's house is so placed that the south span is accessible whether the bridge is open or closed. The concrete roof of the house is cantilevered from one corner to provide unbroken window space for 60 per cent of the perimeter. This layout gives the operator clear vision in all directions for highway and waterway traffic.

A space of only 5 ft was left between the girders and the water line for constructing the pivot piers. Each pier is supported on twenty-seven 20-in. square reinforced concrete piles. To resist lateral and longitudinal forces, 8 of the outside row of piles were battered. In addition, 4 other outside piles were battered in a tangential direction to take care of torsional forces during the operation of the span. The pier is designed as a mat or footing slab and reinforced in both the top and bottom planes.

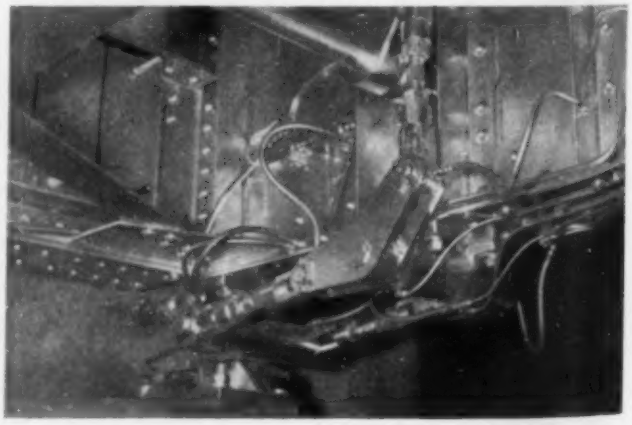
Contract plans called for 70-ft concrete piles for the pivot piers, the length being based on boring data and timber test piles. Two of the permanent concrete piles in the piers were used as test piles. The sandy marl encountered made it necessary to jet them to obtain the desired penetration. One of the piles that was driven to the desired penetration pierced the sand marl formation and entered a soft layer which offered no resistance to driving and no support for the pier. It was then decided to shorten the piles to 55 ft. They were jetted for most of this depth and finally driven the last few feet to refusal without the jet. The holes made by the jet in the marl finally closed up. As a result of this change about 20 ft of sandy material remained between the points of the piles and the soft underlying strata. This depth was deemed sufficient to distribute the pier load over the softer material. The piles were designed for a maximum load of 50 tons and were subjected to load tests of 80 tons without settlement.

PROCEDURE IN CLOSING ALINEMENT

As the channel could only be blocked for 12 hours, the final stages of erection of the structural steel in the north span were difficult. The first operation consisted in placing the end sections of the two girders and filling the splices completely with bolts and pins. Next the floor system was placed and the concrete floor fill poured. The two spans were then closed by hand. The center floor break matched perfectly horizontally but did not match vertically. Top holes in the end splices were reamed and the ends of the girders on the north span were dropped until a perfect matching of the center joint took place. Then the center shear lock castings were set, the lock bars driven, the bolt holes reamed, and the castings permanently bolted. Rear locks and floor breaks required no adjustment except for shims on the bumpers and wedges. After the floor breaks were lined up the splices were riveted, the balance wheels were shimmed, and traffic was admitted to the bridge.

The bridge was operated the first few days by hand. After all adjustments had been completed and the power applied, operation was found to be very smooth and quiet. The power required was so small that one man could easily start and swing the span. The bridge was completed in June 1940 and up to the present time no operating difficulties have been reported.

Preliminary negotiations, preparation of the report, and selection of the bridge type were conducted in cooperation with Lt.Col. John H. Carruth, M. Am. Soc. C.E., who was District Engineer, Norfolk District, at that time. Colonel Carruth was succeeded by Lt.Col. John F. Conklin, under whose supervision the bridge was constructed and completed. L. E. Bozarth was project engineer and A. T. Evans resident engineer for the U.S. Engineer Office. The writer was assisted by M. C. Conkey in preparing the preliminary report, final design, plans, and specifications for the J. E. Greiner Company, consulting engineers.



END LOCK AND WEDGE—NOTE FLEXIBLE GREASE CONNECTIONS

Multiple-Use Aspects of Irrigation Projects

Combined Development of Domestic Power, Navigation, Flood Control, and Recreational Uses May Be Achieved with Proper Planning

By E. B. Debler

Member American Society of Civil Engineers
Hydraulic Engineer, U.S. Bureau of Reclamation, Denver, Colo.

"Greatest good to the greatest number" is a principle readily accepted everywhere. Just how that principle should be interpreted in conceiving specific projects that sometimes involve mutual sacrifices by conflicting but necessarily cooperating interests is naturally not an easy question to settle. In this paper, originally presented before the Irrigation Division at the Society's Denver Meeting, Mr. Debler discusses a number of the intangible factors that are sometimes lost sight of in attempts to allocate costs in proportion to benefits.

The pioneer, with his plowed ditch a few hundred yards long, serving a river-bottom garden patch and a small meadow to provide winter feed for his stock, effected a multiple use of water. He irrigated his farm, he watered his livestock, and he obtained a supply for use in his cabin. The development of irrigation, the requirement for stream regulation, and necessary increase in the size and complexity of ditches and appurtenant structures, introduced more multiple uses. Storage, flood control, power, silt control, navigation, and recreation have become more prominent in irrigation project planning as a result of the growing recognition of the need for them.

Domestic Needs Most Troublesome

Domestic use of water, with the closely related matters of livestock watering and municipal uses, is easily the "problem child" of irrigation. It started with the pioneers, who for convenience caused their little ditches to run throughout the year. Gradually the ditches were extended farther afield to provide livestock with drinking water in pastures or feeding grounds miles from streams. Where potable ground waters are not readily available, distribution systems cover extensive areas and operate continuously through all seasons, although at most only 1 or 2 per cent of the diverted water is actually used outside the irrigation season. At best such conditions entail wasteful consumptive use, and land and crop damage through raised water tables. All too often such waters, up to hundreds of second-feet, are lost by underground escape from the areas where they are most needed.

Communities grow more slowly than the irrigation development that supports them in whole or in part, and their needs should be anticipated by adequate reserves. The needed water could later be secured through condemnation of agricultural water but the strained relations created by this procedure usually lead to the alternative of securing water elsewhere, regardless of cost, and the resulting financial burden reacts on the irrigated area.

While irrigators are willing to suffer occasional heavy shortages in the interest of reduced costs, communities demand unfailing service. Preferential water rights arouse resentment, regardless of character of use. The better plan with storage reservoirs is a disproportionate participation by the communities to ensure the needed reserve through periods of low runoff.

A seldom appreciated but decided benefit to irrigation from municipal uses is the relatively large return flow. Where irrigation consumes, on the average, about 40 per cent of the diverted water, municipal diversions subtract less than half that amount.

Although irrigation canals often divert the entire flow of a stream for years on end, their effect on the heavier floods is usually unimportant, mainly because their combined capacities are small compared with the flood flows. Further factors are the occurrence of winter floods when canals are out of operation, and flood damage to diversion works and the canals themselves.

Where floods derive entirely from melting snows, the modification of irrigation reservoirs for flood control in some cases requires only increased outlet capacity. More often, added reservoir capacity is also needed, with the dedication of some small part of it to flood control use exclusively. So long as the cost had to be met by the irrigators, most of whom were not benefited, little could be done to meet the situation. The Federal Reclamation Act of 1939 recognizes these needs and provides for relieving irrigators of costs properly chargeable to flood control. This ex-

Parker Dam Serves Domestic, Agricultural, and Power Uses
Lines of the Cactus, Torch of the Desert, Are Hinted in Attractive Treatment of Roadway Lighting

DITCH REGULATION WITH A COLLAPSIBLE BULKHEAD—SALT RIVER IRRIGATION PROJECT

tends the long-standing policy of federal assistance on flood control to the irrigated regions. Increased storage capacity results in decreased unit costs, with the result that much more capacity can be justified for combined uses than for separate uses.

The trend toward reservoir control for floods, in lieu of the earlier policy of levee and channel improvement exclusively, is removing the ever-present menace of inadequately guarded and inadequately maintained embankments. The alternative of removing improvements from flooded areas is not so applicable in irrigated as in non-irrigated areas, for the river-bottom soils are usually the better, and sometimes the only agricultural soils in the locality.

Power has in recent years acted as Aladdin's lamp in assisting with the financing of new or supplemental irrigation. Since the operation of a power unit changes neither the quantity nor the quality of the water, power development warrants the utmost consideration, not only on the canals and dams required for an irrigation project, but also at points where project water development may enhance power values. Adjustments in canal and reservoir locations and capacities are usually justified by added power production.

Power development is not an unmixed blessing. Power water-right laws are in general existence and can be invoked to enforce priority of such rights when new development is limited by the extent of the water supply, while power needs, although as essential as irrigation, can be met from substitute sources. Power development should therefore be subordinate to irrigation development, and should not be permitted to become a hindrance to it. On the other hand, power affords one method of distributing project costs to a large group that benefits directly or indirectly but is not reached by irrigation charges. Careful second thought should be given to the development of power sites where the urge for revenues may foster unseasonal operation of canals or encroachment upon flood storage capacity Each will require unremitting vigilance to avoid mutual conflict.

The main canal, in times past, was often considered a potential shipping route. While many canals have waterways adequate for large craft, the economy of water movement is no match for the superior flexibility and speed of other forms of transportation, even where all-year water service is the rule. Irrigation without stream regulation results in loss of water for navigation except within reservoir areas. If full regulation of stream flow for navigation purposes is both practical and economically justifiable, then any irrigation development requires a compromise between irrigation and navigation.

A factor often overlooked in irrigation development is its effect on the silt problem in navigation. The detention of water for irrigation will tend to decrease and equalize navigation depths, but this feature may be either offset or accentuated by silt-load changes, and corresponding changes in maintenance costs.

WILD LIFE AND RECREATION

Fish and wild life factors grow increasingly important. The unscreened canal headgate is highly destructive to fish, for many are killed each time the distribution system is drained. The diversion of the entire flow of a stream not only menaces the life of fish downstream, but interferes with the existence of migratory species. Although most states have laws requiring the screening of intakes, these are seldom enforced. Some states have laws requiring fishways at dams.

In many instances, officials administering the streams are meeting with considerable success in their attempts to accomplish the desired ends without the aid of specific laws.

Reservoirs have invariably increased recreational opportunities and fishing. Migratory fish have decreased in number on some streams so controlled but their place has been more than filled, as far as recreation

ALL AMERICAN CANAL TO FURNISH BOTH POWER AND WATER FOR IMPERIAL VALLEY
Enormous Proportions of Canal Cross Section Apparent in This View

is concerned, by other fish. In the states of Colorado, Wyoming, New Mexico, and Utah, the heaviest fishing occurs in or adjacent to reservoirs. Although Boulder Dam and Lake Mead are far from cities and on no prominent highway, they receive more visitors than such world-known national parks as Yellowstone and Yosemite.

The dead storage in reservoirs for power head and silting provides also for fish and bird life. Fish ladders, elevators, and other facilities have been provided at many dams to permit passage or propagation of migratory fish, often at staggering expense on Government dams, without assurance of ultimate success. Not enough appears to be known of fish habits, nor enough attention given to the possibilities of substituting desirable non-migratory species for those unable to cope with river improvement works.

Most reservoirs have been made wild life refuges and attract birds and animals in great numbers. The universal condemnation of irrigation works as destructive of wild life has given way to a realization that such works are actually helpful. Their importance in this respect will grow with time.

Silt problems comprise another aspect of multiple use. Every reservoir intercepts silt and reduces the maintenance costs on irrigation ditches, both for those who pay for the reservoir and for others. Also, improvement in the stability of stream channels affects a wide variety of interests, and the improvement of operating conditions is available to all diverters of water. Occasionally, as at Boulder Dam, desilting is of major importance, although not mentioned in the authorization of the project.

The Department of Agriculture is devoting much attention to the reduction of floods and silt by improving land use and by increasing vegetation in drainage areas. Much can no doubt be accomplished by these means, but the proper extent of such programs, considering

Waste Sands Yield Fine Apples When Mixed with Water from Owyhee

initial and maintenance costs, reduction in runoff due to increased loss of water by plant use, and reduction in silting, is still a question. Where water is more valuable than reservoir silt capacity, the justification must rest wholly on an increased value for the protected lands, exceeding the value loss of from reduced water supplies in irrigated areas.

Salinity control is a unique problem encountered in the Sacramento–San Joaquin delta where some 400,000 acres of tidal lands are traversed by a network of sloughs. The lands have an average elevation that is below high tide and are protected by levees. Irrigation is necessary from May to October, and water for it is taken from sloughs subject to salt water invasion. Crop damage from the use of salty water, and crop loss resulting from the necessity of leaving lands idle in years of widespread salt-water invasion, have amounted to several millions of dollars in a single year. The Central Valley project will stop such salt-water invasions by maintaining an adequate counter stream of fresh water from storage.

A full realization of the possibilities of multiple uses on irrigation projects requires their recognition prior to construction. Comprehensive planning, and adequate financing for each use are essential. Unless funds are provided for all purposes, some will receive only incidental recognition. This is particularly true of irrigation projects whose major cost must be repaid by the irrigator from limited farm earnings.

SOME BENEFITS NOT EASILY EVALUATED

Allocation of reservoir costs may be achieved by several methods. Three will be briefly described. The first of these, allocation by relative benefits, involves determination and evaluation of annual benefits to recognized uses. The more common uses are irrigation, flood control, power development, municipal and industrial water supplies, silt control, and recreation. Less frequently benefits accrue from pollution abatement and navigation.

Irrigation benefits arise mostly from conservation of waste waters, re-regulation of used waters to secure greater efficiency in use, and reduction in desilting costs. Conservation and re-regulation values involve anticipated changes in crops and gross crop values that are not very difficult to determine. But is this the value of such service? Increased crops involve increased outlays by the irrigator for farming operations from

Specialty Crops Exemplify Agricultural Use of Water—Imperial Valley

LEVEES SOMETIMES GIVE WAY, RESERVOIRS MORE RARELY
But Costs of Reservoirs May Be Made Less Onerous by Distribution to Several Uses

seeding to crop haulage and, in addition, increased taxes and equipment costs. While the irrigator's increased spending adds to employment and business, thereby constituting a benefit to the community, for the added water the irrigator can at most pay what is left after meeting such costs. Furthermore, his general condition is unimproved unless a reasonable part of the net income is left to him for his risk and investment in the joint undertaking. Is, then, the irrigation benefit what the irrigator will willingly pay, or is it nearer the increase in gross crop values? For example, the Colorado type of water conservancy district permits ad valorem assessments on all property within the benefited area and achieves a closer approach to repayment ability based on the full extent of benefits than does the irrigation district.

Evaluation of flood control benefits necessitates a determination of appropriate annual flood damages. This involves a consideration of flood frequency and the relation of damage to flood crest or volume, with and without the proposed control. Short stream-flow records complicate flood frequency studies, and efforts to estimate damages from past floods develop a woeful lack of reliable data. Further steps to adjust such results to comprehend continuing improvements with rising valuations increase the difficulties. Also, the question of proper inclusions is not simple. The periodic damages to properly located and reasonably constructed houses, highways, bridges, dams, railroads, and the like are always recognized as appropriate items, as are land damage from meandering and from surface deposits of debris and gravel. Crop restrictions for fear of flooding, increased land values from removal of flood menace, and interruption to traffic and business are less certain quantities.

On the basis of competitive power development, power benefits are usually thought easy to determine. That is true where the market is able to absorb the new power output without stress, and where competitive development costs can readily be ascertained. All too often, more complex factors must be considered. Among these are the implications of transmission to a considerable distance, standby power costs, or use of power in irrigation pumping or in electrochemical or electrometallurgical industries where power values may be sharply limited by other elements. The policy of fostering power uses by low rates may also sway the balance.

Recreational benefits are readily recognizable but their valuation is seldom seriously attempted. Reliable data are scarce and funds have not become available for such purposes on irrigation projects. No attempt to evaluate wild life protection has come to the writer's attention.

Pollution abatement is a rather broad term. Usually applied to sewage dilution, in this case it also includes the repelling of saline waters by an adequate opposing stream, and the re-regulation of stream flow by mixing the wasted flood waters of low salt content with the fully used low-water flows of higher concentration. The monetary benefit of sewage-pollution abatement is not easy to evaluate, but the agricultural benefit from reduced or changed dissolved constituents is somewhat more easily determined. Elimination of teredo damage is an occasional incidental advantage.

The second mode of allocating costs involves a determination of the relative degree of use of reservoir capacity for each purpose. Waters may be released simultaneously for power, navigation, pollution abatement, and irrigation. If each use is charged with the amount it requires, duplications result and the total use may exceed the actual releases. Alternatively, the actual releases at any time for multiple use may be prorated. However, relative use varies from year to year, and the adoption of a compromise average is necessitated. For further comparison such releases must in turn be converted into storage capacities for flood control, silting, and power head. Intricate problems are also introduced in allocating, as between storage and power development, the cost of tunnels and outlet works used for diversion during construction and later for the release of water for various purposes.

HYPOTHETICAL SEPARATE COSTS FOR ALLOCATION

Allocation on the basis of construction costs is a third plan, which involves the determination of reservoir cost when built for each purpose singly. The determination should be made on the basis of existing stream flow and the desired regulation. Aside from the expense of making numerous separate operating studies and preparing separate plans and estimates for reservoirs of various capacities and types of use, the resulting costs to purposes requiring small reservoir capacity are likely to prove too burdensome to justify their inclusion. In turn, their omission will raise costs for the more important uses. To be fair to the various uses, it would be necessary to base reservoir costs on the cheapest suitable sites that could be found for each of the purposes.

At times it has been the custom to allocate to one use, such as flood control, all that can be so allocated on the basis of benefits, and to allocate the remainder to another use, such as irrigation, regardless of the relation of allocated costs to benefits for this second use. This method might well be called the incremental cost method. There appears to be little to commend it except the ease of arriving at an allocation. The relative results with this method will necessarily depend on the use that is to be taxed to the limit for the basic allocation.

Trick Mechanisms Sustain Modern Aircraft

Far from Simplifying Construction, Every Improvement in Performance Demands Complicated Auxiliary Equipment

FROM A PAPER PRESENTED BEFORE THE SAN FRANCISCO SECTION

By W. W. BEMAN

ASSISTANT CHIEF RESEARCH ENGINEER, LOCKHEED AIRCRAFT CORPORATION, BURBANK, CALIF.

WHY the automobile assembly line could not be turned into a plane assembly line immediately on the declaration of the national emergency is a question often asked. Some of the factors that would tend to multiply the difficulties of any such rapid transformation are disclosed very simply and a little whimsically in the present account, which was originally delivered by Mr. Beman before a meeting of the San Francisco Section of the Society.

BACK in 1917–1919, the available aircraft power plants turned out a maximum of about 200 bhp (brake horsepower). Moreover the engines were unreliable, for they were subject to chronic cases of valve breaking, push rods jumping, ignition systems collapsing, and bearings giving out. If we were to take the design of such an engine and scale it up to the 2,000-hp class of the modern one, we would find it necessary to build an engine some $6\frac{1}{2}$ ft in diameter instead of 4 ft, and weighing something more than 5,000 lb instead of approximately 2,000 lb. In addition, the engine would be so unreliable that it certainly could not be depended upon for commercial work.

In order to overcome the weaknesses of the early engines, it has been necessary to concentrate, first of all, on cooling. A look at the present-day cylinder head will show a phenomenal development in the casting and machining of a multitude of very deep and closely spaced cooling fins.

By far the greatest reason, however, for the tremendous increase in power that has been achieved since that time is the development of the engine supercharger. The complication of this item is typical of the modern airplane in general. It would seem that the problem of merely forcing air into the engine by means of a pump should be relatively simple. But it is not; the modern engine requires a centrifugal-type blower which may be geared to the engine directly or run by a separate auxiliary power plant. In either case, if the engine is to be economical from the standpoint of weight, the impeller must turn over in the neighborhood of 23,000 to 25,000 times per minute. The mechanically driven supercharger must therefore have a step-up gear ratio in the neighborhood of 10 to 1 or 12 to 1—which obviously means that any sudden changes in engine rpm cause tremendous shock loadings on the supercharger gear system. It is consequently necessary to install in this supercharger transmission, an overriding clutch to prevent breakage of the transmission system. Thus, by the addition of an impeller, a diffuser, a 10-to-1 step-up transmission, and an overriding clutch, we have converted a sea-level engine into an altitude engine in which the maximum power is developed at a height of from 7,000 to 8,000 ft.

This system, however, is not nearly complicated enough for present-day needs. In the commercial field, it is desired to have sufficient rating to permit flying in the sub-stratosphere, where storms and rough air are comparatively non-existent. Consequently we must do yet another trick—develop not a single-speed transmission, but a two-speed transmission with a gear shift included, an alteration that obviously increases the complication of the transmission system and of the control system from the engine to the pilot's cockpit. In fact, the present state of the art requires that we have, besides the two-speed transmissions, two blower systems in series, each blower doing part of the final supercharging job and having its own respective gear ratio, depending upon the altitude and power requirements of the airplane.

By the time we have reached the two-stage type of engine supercharger, we have run into a new complication—the heat developed by compression. It is necessary in this last type of supercharger to insert a system that will cool the air after compression and before entry into the carburetor. If this is not done, the engine will be unable to develop its full power.

In developing this supercharger, it was found necessary to revise the carburetor systems each time an increase in altitude rating was attained. The present-day carburetor is far from the old butterfly type; it has two

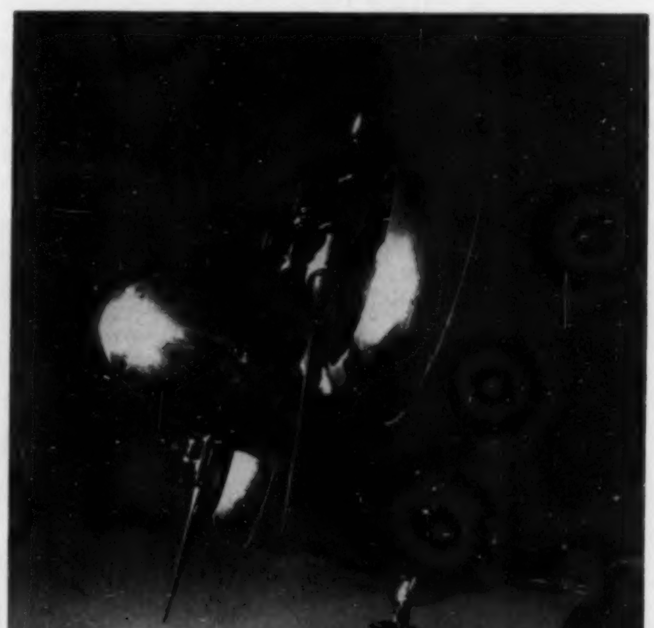


Photo by J. H. Washburn

NOSE AND NACELLES OF A PRESENT-DAY TRANSPORT

In a Bomber the Nose Is Occupied by the Bombardier; Army Fliers Term That Crack-Susceptible Compartment the "Meat Can"

large cam-like mechanisms controlling the air flow and a myriad of small mechanisms controlling the operation of the cams. The small mechanisms make corrections for air temperature, altitude, and fuel-air ratio; without this regulation the engine would either detonate, back fire, or corrode internally.

As a further example of the complications involved in modern aircraft, it might be noted that the gasoline itself presents a problem if the engine is designed to develop power at an altitude above 30,000 ft. Aircraft gasoline, because of its low vapor pressure, starts to boil automatically under the reduced atmospheric pressure at approximately 20,000 ft. By the time an altitude of 30,000 ft is reached, the gasoline in the fuel tanks is boiling so vigorously that the fuel pumps can pump only bubbles. This difficulty has been partially alleviated by developing carefully made fuel line fittings, such as valves, elbows, and pipe connections, each piece carefully machined to insure light weight and smoothness for obtaining the least possible resistance to the fuel flow.

Photo by J. H. Washburn

LANDING-GEAR RETRACTING MECHANISM AND HYDRAULIC STRUT

If altitudes of 40,000 ft are to be used satisfactorily, even this will not suffice; not only the engines but also the gasoline tanks will have to be supercharged. Supercharging the tanks presents a problem, since if the air is used for this, an extremely explosive mixture of gasoline vapor and air results. If, on the other hand, some readily available inert gas, such as carbon dioxide, is used, the gas dissolves in the fuel and again results in improper functioning of the engine. By means of a system of automatically controlled valves, it seems possible to let the fuel's own vapor do the supercharging without danger of explosive mixtures or the complication of an auxliary gas pressure system. It does require, however, that a fuel pump be installed inside the gasoline tank itself and this, in turn, requires the installation of a separately driven and controlled power system to drive the fuel pump.

It becomes essential now to supercharge the cabins in order that personnel and passengers may continue to function properly. At altitudes above 15,000 ft oxygen must be used if the cabins are not supercharged. Oxygen masks or breathing tubes are uncomfortable devices, and moreover are not satisfactory above 25,000 ft.

The first effect of insufficient air is a dulling of the senses that makes it impossible to do simple things such as reading or telling time. Any sudden movement of an individual in this condition will cause unconsciousness. These defects are overcome when the pressure inside the cabin is maintained at 10 lb per sq in. or more. However, to maintain satisfactory cabin pressure in a commercial transport designed to fly in the sub-stratosphere, it is necessary to install a refrigerating system to cool the compressed air before it enters the cabin. This in turn requires a complicated control system to maintain constant pressure, as a fluctuating pressure is extremely annoying. Some type of humidifying and deodorizing system must also be installed. The "Rube Goldbergs" required to accomplish all this can well be imagined.

The propeller, normally an efficient means of converting engine power into thrust, does not have a high efficiency unless its rpm is suited to the altitude conditions. For most airplanes this requires the installation of a transmission system between the engine proper and the propeller shaft. The transmission required, incidentally, is a reduction transmission causing the propeller to run 30 to 50% slower than the engine. As higher altitude ranges are sought, it becomes increasingly difficult to find one gear ratio that will serve satisfactorily both at sea level and at high altitudes. It therefore becomes necessary to install a two-speed propeller transmission system, requiring a complicated clutch and an automatic synchronizing device, so that the propeller gear ratio can be changed in flight as higher altitudes are reached.

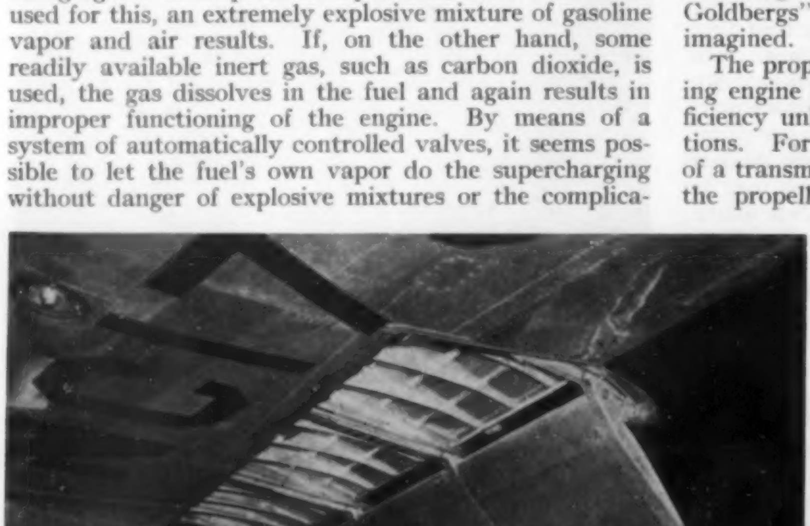


Photo by J. H. Washburn

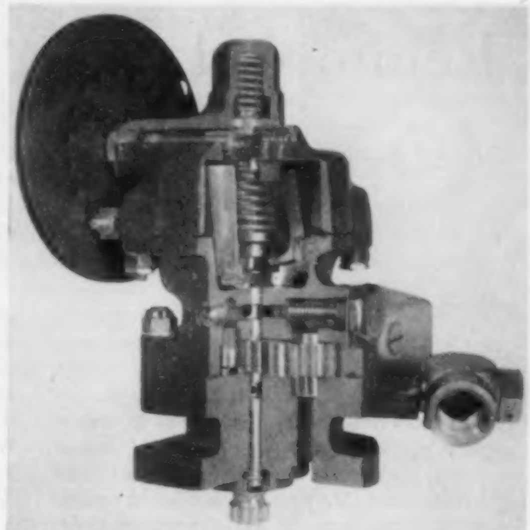
FLAPS PERMIT REDUCED LANDING SPEEDS—FULLY EXTENDED POSITION DURING ASSEMBLY

If satisfactory operation of airplanes is to be maintained throughout summer and winter, controllable cooling systems must be used on the engine, the oil coolers, and other auxiliaries. The oil-cooler regulator would seem to be satisfactorily taken care of if a simple temperature-operated thermostat controlled the shutter to the oil cooler. But this is not the case. In cold weather, the oil in the cooler tends to congeal, decreasing the oil flow through the engine itself. If congealing occurred, the oil temperature in the engine would increase

and the thermostat would open the shutter, thereby further congealing, in fact, solidifying, the oil in the oil coolers, with the result that the engine would immediately burn out its bearings.

It is obvious that an air-line transport incorporating even the features already described has grown to rather large proportions and requires a tremendous amount of power. Since it does not seem feasible, at the present time, to increase the power output of the engines themselves, it has been necessary to use more engines. Result—the four-engined airliner.

As can well be imagined, the ability of the pilot to directly control the airplane has diminished immensely. In fact, to attain full control he would have to be able to exert a force of approximately a ton on the rudder pedals. Since this is obviously not within reason, a power boost system has been devised to accurately and absolutely proportion all the control forces so that the pilot need exert only a small percentage of the total effort required and yet have that definite and delicate "feel" of the controls. On top of all this, provision must be made so that even in the event of the loss of all booster power, the airplane can still be satisfactorily governed although perhaps only to a limited extent.



COMPLICATED MECHANISM FOR A SIMPLE FUNCTION
Pump and Control Valve for Hydraulic Operation of Propeller Blade Adjustment

An airplane then, if it had all these "Rube Goldbergs," would be able to fly long distances, high above the usual seasonal storms, and the passengers would be unaware of any altitude effects. Since, however, such a flight presupposes that the airplane would probably not be within sight of the ground for several hours, navigating and communication equipment are needed. Such devices consist of instruments for celestial navigation, direction-finding radio loops, beam signal receivers, terrain clearance indicators, and landing indicators. These latter instruments are all radio-operated devices that require another crew member. The crew has now grown to pilot, copilot, navigator, radio operator, flight engineer, flight captain or supervisor, and stewards.

In military aircraft, the luxurious accommodations required in civil aircraft do not have to be maintained. Yet recent experience indicates that satisfactory cabin supercharging and air conditioning will be essential in the newer military types to prevent personnel from becoming unconscious at high altitudes. The airplane structure must be designed to withstand tremendous load factors in order to assure extreme maneuverability. The Germans, for instance, have carried on extensive research to determine the effect of acceleration on the human body in an attempt to find ways and means of increasing the load factors that can be withstood by personnel.

At the present time, if a load factor of four is maintained for more than a few seconds, a person loses his sight, and he becomes unconscious at a load factor of 6 to 8. Yet there are times in rapid maneuvering when load factors as high as 12 or 13 have been encountered, and airplanes must be designed to withstand this.

European experience would seem to indicate that we have need for extremely fast interceptors with very heavy armament. There is need also for large, heavy-duty, long-range bombers which, in addition to their normal bomb load, will have tremendous fire power in the form of large-caliber machine guns and cannon to protect themselves against enemy interceptors. Armor plating for the protection of personnel and a composition armor plating for the protection of fuel tanks are also being used in Europe. Since the weight of a bullet-proof shield for the fuel tanks would be prohibitive, the function of the composition lining applied to the tanks is simply to seal up the hole left by a bullet.

MORE COMPLICATION SEEN IN FUTURE DEVELOPMENTS

It can safely be said that the complications of the modern airliner or military airplane have not by any means reached their peak. Every attempt to simplify the design of an airplane leads to nothing. Although it seems at present that the performance can be improved in the future to the point where non-stop, transcontinental runs can be made in 6 to 7 hours, and that the speed of military aircraft can soon compete with the speed of sound, this will only be made possible by many auxiliary devices, each of which will greatly increase engineering and manufacturing complications.

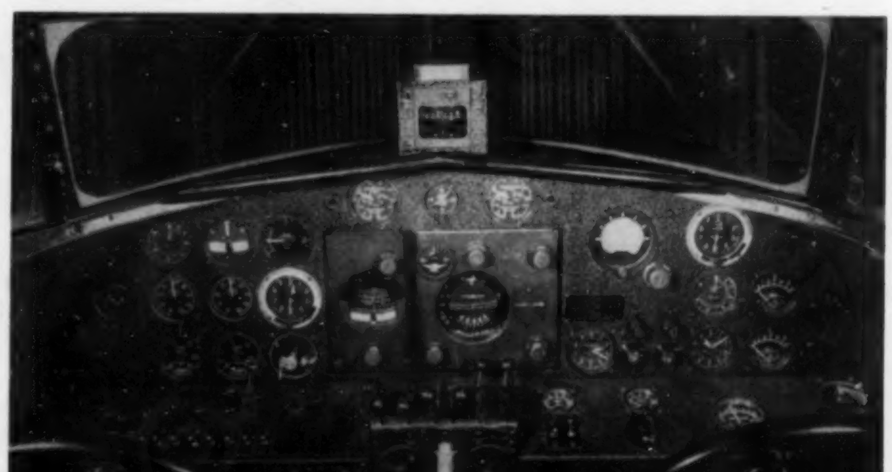


Photo by J. H. Washburn

WHY PILOTS GO TO SCHOOL—THE INSTRUMENT PANEL OF A MODERN PLANE

Tests of Beams Reinforced with "Bundle-Bars"

Relaxing of Specifications on Permissible Stresses Suggested as Limited Investigation Indicates Close Spacing of Steel May Cause No Loss of Supporting Power

By Homer M. Hadley

Associate Member American Society of Civil Engineers
Regional Structural Engineer, Portland Cement Association, Seattle, Wash.

In the light of the present emergency, every possibility for conserving material or labor deserves careful study. If it can be shown that accepted factors of safety are greatly in excess of needs, even under a restricted range of conditions, then, with careful regard for those limitations, the factors should be revised so that any possible relief in the defense construction burden may be fully realized. The implications of Mr. Hadley's paper are also in accord with the increasing interest in the theory of limit design. As always, however, caution must be exercised in applying the results of any tests to conditions of construction not comtemplated in the investigation.

Standard specifications for reinforced concrete variously require $1^1/_3$, 2 or 3 in. of concrete between the several bars in a layer of beam reinforcement, and when there is more than one layer, 1 to 2 in. between layers is required. Not infrequently the breadth and depth of beams are determined by these requirements and the beam size is increased beyond the section required for shear. Primarily to reveal what if any harm would result if such spacing requirements were ignored, four beams were recently made and tested in the testing laboratory of the City of Seattle.

These beams were 6 in. wide, 12 in. deep, and 10 ft long. They had an effective midspan depth of $10^1/_2$ in. Two of them were each reinforced with a single 1-in. sq bar extending the full length of the span. In one beam this bar had straight ends, in the other beam, hooked ends. The other two beams were each reinforced with the same cross-sectional area of steel but obtained with four $^1/_2$-in. sq bars "bundled," that is, wired together in a tight compact bundle, two upper bars directly above two lower bars and all four in as close contact as their lug deformations would permit. The lower of the "bundle bars" ran through straight from end to end of the beams and terminated in large hooks. The upper bars were stopped off at two different places, bending up at 45° to the top, where they were anchored. These bent-up bars constituted the sole web reinforcement of the "bundle-bar" beams. The other two beams had their webs reinforced with $^3/_8$-in. stirrups at maximum spacing. Because profound alarm is frequently expressed at the thought of having horizontal construction joints extending longitudinally in the stems of beams—"They'd fail in horizontal shear!"—such a joint was simulated in one of the "bundle-bar" beams. After about 4 in. of concrete had been placed in the form for this beam, the concrete was roughly struck off, and on both sides of the central bent-up bars, strips of brown wrapping paper $2^1/_2$ in. wide, extending the full length of the beam, were placed on top of the bottom concrete. Then the remaining concrete was filled in on top of the wrapping paper. When the forms were removed no trace of the paper was to be seen on either side of this beam. Later, when the beam was opened up after testing, the paper was found to be intact and unpunctured and in approximately its original position. Tamping and puddling of the concrete placed over it had somewhat puckered and displaced it so that it constituted a very irregularly warped rather than a plane surface, but there was no adhesive bond between upper and lower concrete.

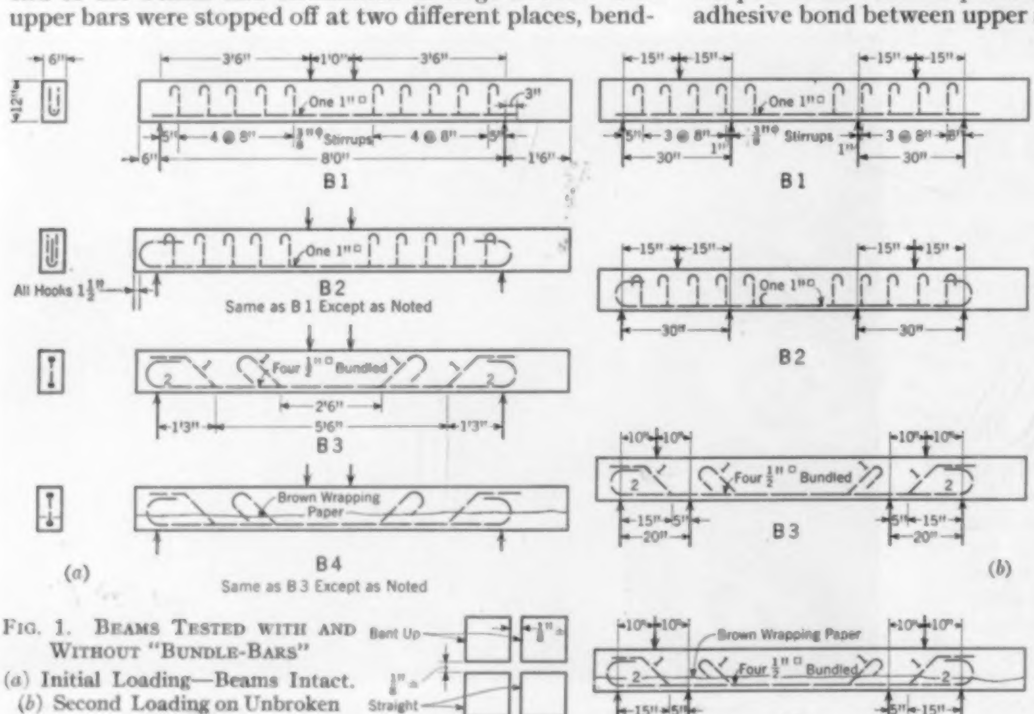


Fig. 1. Beams Tested with and Without "Bundle-Bars"
(a) Initial Loading—Beams Intact.
(b) Second Loading on Unbroken Ends

Details of the beams and of their loading are shown in Fig. 1. The concrete was ready-mixed at a central mixing plant about $2^1/_2$ miles from the laboratory. The cement content was 1.50 bbl per cu yd and the slump was 3 to 4 in. Early-strength cement was ordered but the tests were postponed until the beams were 14 days old. A test cylinder then showed a strength of 4,530 lb per sq in. No tests were made on the reinforcement. This was of intermediate-grade new billet stock, which normally has a yield point ranging from 52,000 to 58,000 lb per sq in.

Under two symmetrically placed center

loads, 12 in. apart, on a span of 8 ft, all four beams failed by tension in the steel, the percentage of which was 1.59. In all beams failure occurred at midspan, a fine crack between the two applied loads which had developed earlier suddenly widening as the steel passed its yield point. There were no shear cracks at the ends nor was there any sign of weakness or slippage in the beam containing the brown wrapping paper. In fact it was this beam which carried the greatest load.

The total applied loads—that is, the sum of the two center loads—were as follows:

Beam No.	Reinforcement	Total Applied Load, Lb	Average Load, Lb
1	1—1 in. sq, straight ends	22,550	22,780
2	1—1 in. sq, hooked ends	23,010	
3	4—$^1/_2$ in. sq, "bundled"	23,980	24,320
4*	4—$^1/_2$ in. sq, "bundled"	24,660	

* Contained the wrapping paper.

The 7% greater load carried by the "bundle-bar" beams probably results from the fact that the $^1/_2$-in. sq bars have a higher yield point than the 1-in. sq bars because of the greater rolling they receive in manufacture. But whatever the cause of the greater carrying capacity of these beams, they did possess it. There was nothing of any sort to indicate or suggest that this "bundled" arrangement of reinforcing bars was not a proper or desirable one.

The corresponding unit stresses in the beams, assuming n equal to 8 and the weight of the concrete to be 160 lb per cu ft, were as follows:

Beam No.	M_{max}, in In.-Lb	f_s	f_c	Unit Shear	Unit Bond
1	481,200	52,800	4,270	212	318
2	490,800	53,800	4,350	216	324
3	511,300	56,100	4,540	225	450
4	525,500	57,600	4,660	231	462

Although the primary purpose of the test had been fulfilled, the ends of the beams had not been injured and it was believed they could be tested, on short spans, to

Diagonal Tension Failure from Shear Loading
Knife Indicates Unexpected Vertical Split

show the influence of the hooks and the brown wrapping paper. Consequently on the following day the ends of $B1$ and $B2$ were tested, and five days later the ends of $B3$ and $B4$. This was accomplished by putting first one end of the beam and then the other into the testing machine while supporting the long projecting end with rope slings and chain block in such a manner that its weight did not affect the loaded part. In all cases one support of the short spans on which the ends were tested was made to coincide with the support of the original

Beams as They Appeared After First Tests
Full-Length Members Failed at Center in Tension—Cracks Faintly Visible

full-length beam. The other support therefore came toward the middle of the full-length beam. The ends of $B1$ and $B2$ were tested with a single center load on a 30-in. span, and the ends of $B3$ and $B4$ were tested with a single center load on a 20-in. span.

The tests with $B1$ and $B2$ show in striking contrast the influence of hooked bar ends on load-carrying capacity. Observe in Fig. 1 (*b*) that the four stirrups included in the 30-in. section tested are not symmetrically disposed with respect to the span. In all cases failure came with the formation of a diagonal crack on the side adjacent to the end and not towards the middle of the beam, although it was on this inner side that the bars had been most highly stressed in the original testing. An eccentricity of bearing either at the support or at the load occurred during the tests of one end of $B2$, and caused a markedly different rupture and a lower final load than would have been obtained otherwise. The other three ends failed in practically an identical manner. The results are given in the accompanying table.

Beam	Loads, Lb	Average Load, Lb	Unit Shear	Unit Bond
$B1$ (straight ends)	30,980 39,880	35,430	325	488
$B2$ (hooked ends)	*50,240 59,110	54,675	500	750

* Eccentric bearing.

In the case of the $B3$ and $B4$ ends, tested on a 20-in. span, the main reinforcement consisted of the two lower $^1/_2$-in. sq bars of the midspan "bundle," and the only bar traversing the web—the inclined portion of the outermost bent-up bar—was located directly beneath the load and was practically ineffective in resisting shear. In fact the reason for selecting the 20-in. span was to render this bar as ineffective as possible and to achieve symmetry of web conditions as nearly as possible. The webs were therefore substantially devoid of reinforcement and are to be regarded as plain concrete. These were the results:

Beam	Load, Lb	Average Load, Lb	Unit Shear	Unit Bond*
$B4$ (wrapping paper beam)	62,440 63,660	63,050	543	1,086
$B3$	66,190	....	570	1,140
	81,630		703	....

* Based on 3.00 sq in. of bond surface, that is, eliminating sides in near contact.

The extraordinary load carried by one end of $B3$, 81,630 lb, scarcely warrants averaging with the load carried by the other end. In view of the high computed

values of steel stress—60,000 to 63,000 lb per sq in. in the other three ends—it is apparent that, on the short 20-in. spans, horizontal thrusts were developed at the end bearings. A certain amount of load was therefore carried by arch action in all beams, and about 30% of the load was carried by arch action in the extreme case. Attention is, however, directed to the unit shears, which are computed from the full applied loads in accordance with current practice.

There was no slippage or trace of movement in the *B*4 specimens as a result of the brown wrapping paper, but they did not carry as much load as did the *B*3 ends. It is not to be overlooked, however, that with respect to load, unit shear, and unit bond, the *B*4 specimens, despite the wrapping paper and with only two $^1/_2$-in. sq bars, developed higher stresses than the *B*2 specimens with the 1-in. sq bar.

With all these beam ends, the load was applied directly to the concrete on a steel plate, $1^1/_2$ in. wide, extending across the beam from side to side. There was no bedding with plaster of paris or any distributing device. The full loads were applied to the beams through a contact area of 9.00 sq in. Therefore a load of 63,000 lb produced a unit bearing stress of 7,000 lb per sq in. and the maximum load, 81,630 lb—more than the weight of two loaded 20-ton trucks—induced a unit bearing of 9,070 lb per sq in. The concrete in this case was starting to crush, but there were no signs of local distress with any of the other beam ends.

After the load tests were completed, *B*3 and *B*4 were turned upside down and the concrete was knocked off to expose a side and what had been the bottom of the "bundle bars." It was found that the spaces, averaging $^1/_8$ in. wide, between the individual bars of the bundle, both vertical and horizontal, had been completely filled with fines of the concrete; no voids were discovered.

After the tests just described, two small beams were made, 6 by 12 by 32 in. over-all, each reinforced with three $^1/_2$-in. sq bars which terminated in 6-in. diameter, 180° end hooks with 4-in. straight ends. These were tested on rollers to eliminate horizontal thrusts. The webs were not reinforced in any manner. The span was 20 in. and there was a single center load. Two cylinders were made of the concrete used in the beams, which was of the same mix and consistency used in the larger beams.

At 4 days, one cylinder gave a strength of 2,350 lb per sq in. At 7 days one beam failed in diagonal tension under a load of 54,460 lb. A large 45° crack developed in the web, and from the support, cracks followed around the hooks of the bars, roughly paralleling their inner and outer surfaces. The unit shear at failure was 477 lb per sq in. At 14 days, the second cylinder gave a strength of 5,120 lb per sq in. and the second beam failed under a load of 53,780 lb in a manner practically identical with the other beam. The unit shearing strength of this beam was found to be 472 lb per sq in.

BEAM *B*3 WITH MORTAR SLIVERS PROJECTING BETWEEN BARS
Mortar Was Loosened in Knocking Off Outer Concrete

BUNDLE-BARS EXPOSED AFTER TESTS WERE COMPLETED
Beams Inverted—Lower Beam Contains the Horizontal Joint of Wrapping Paper

These tests were made in damp curing conditions without any drying. As with the larger beams, the load was applied directly to the tops of the beams by a steel plate $1^1/_2$ in. wide and without bedding, for the definite purpose of making loading conditions, if anything, severe and unfavorable. Small plates, $1^1/_2$ in. wide, were introduced between the beams and the rollers. Why the second beam did not develop greater load-carrying strength than the first is not known. A slight crushing at the edges of this beam under the loading plate occurred but otherwise nothing abnormal was observed.

It is recognized that the amount of test data presented here is very limited indeed. However, it is submitted as being of interest in showing the load-carrying capabilities of concrete when standard specifications are ignored. As one engineer well acquainted with specifications remarked, "You have done everything wrong." But there would seem to be a need for a general reexamination of standard specifications if we are to avoid what Dr. Fritz von Emperger described (*The Structural Engineer*, March 1934) as "petrified rules which we are in the habit of taking for granted."

With this in view, consider a few of the questions suggested by the results of these tests:

1. Why, when reasonably rich mixes and good mortar are used in bridge work, should not "bundling" of reinforcing bars be permitted? In concrete joists in building work it would frequently be possible with such "bundle-bars" to effect a considerable saving of steel by stopping off bars not needed for moment.

2. Since all four beams, with a steel percentage of 1.59, failed by tension in the steel, it is apparent that the quantity and physical characteristics of the steel constituted their load-carrying limitation. Other tests have shown tension failures with varying percentages of reinforcement up to 3.0. The paper, "Tests of Bonding of Floor Finish to Slabs of Haydite or Gravel Concrete," by F. E. Richart, M. Am. Soc. C.E., and U. P. Jensen (*Proceedings*, American Concrete Institute, 1931, p. 339), reports tension failure with roughly 1% reinforcement in slabs made of a 1 to 10 mix. The question then is, why should concrete stresses even be computed, let alone be limited when the steel percentages are such that the steel fails in tension rather than the concrete in compression?

In the case of these four beams, the maximum applied loads would be 3,660, 4,470, or 6,080 lb, respectively, depending upon the value of the maximum working stress permitted in the concrete in bending—whether 750, 900, or 1,200 lb per sq in. as apprehensiveness varies. The least load carried at 14 days was 22,550 lb. With double the percentage of steel and the same effective depth,

CLOSEUP SHOWS MORTAR FILLING NARROW SPACE BETWEEN BUNDLE-BARS

Wrapping Paper Is Almost Indistinguishable Irregular Line from 1 to 2 In. Below Bars

should anyone want to so reinforce such beams, this failure load would become about 60% greater, or about 36,000 lb. But the maximum applied loads permitted with these working stresses would not change greatly; with 3.18% reinforcement they would become 4,660, 5,560, or 7,670 lb. Certainly these are goodly quantities of safety to provide against the perils and hazards of failure by flexural compression.

3. Considering the tests of the ends of beams, made from the same original batch of ready-mixed concrete, it is apparent that the so-called "unit shearing strength" of the concrete (of $B1$ and $B2$) varied around 60%, depending not upon differences in the concrete itself but upon variation in the end conditions of the main reinforcing bars. Why should not nomenclature be revised to focus attention where it belongs? Why should not so-called permissible shearing stresses, if they are to persist, be advanced to values giving reasonable rather than unreasonable factors of safety? Under current bridge design practice the concrete mix used would arbitrarily be assumed to have a 28-day cylinder strength of 2,500 lb per sq in. or perhaps the dizzy strength of 3,000 lb per sq in. Then, if $B3$ or $B4$ could indeed be tolerated at all with the "bundle-bar" reinforcement, they would be permitted maximum unit shears of 75 or 90 lb per sq in., depending on the assumed 2,500 or 3,000-lb strength of their concrete. This is but another way of saying that the maximum loads allowed to come upon them would have been 8,700 or 10,500 lb. Yet 62,440 lb was the minimum load at failure of either $B3$ or $B4$ at the age of 20 days. And $B4$ had the brown wrapping paper running through it! True, these were short, relatively deep beams, but standard specifications make no distinction between permissible shear in short and long beams.

4. Why the frequently voiced apprehensions over horizontal shear in concrete beams?

5. Wherefore the caution, the alarm, implied in standard specifications by the permitted bearing values? For example, the American Association of State Highway Officials allows 600 lb per sq in. on "concrete masonry," but says nothing about bearing under "Concrete Structures" which immediately follows "Bearing on Masonry." The interpreter therefore hesitates to allow more than 600 lb per sq in. in structures. Yet with these $B3$ and $B4$ beam ends +7,000 lb per sq in. was sustained without signs of distress by three of them, and the fourth began to fail by crushing under a load of 9,070 lb per sq in. It is worth reiterating that the load producing this unit stress, which applied to only 9 sq in. of beam surface, was in excess of the weight of two standard H-20 trucks. Of course the flexural compressive stressing of the concrete here would materially increase its bearing strength, but even so there does not appear to be any reasonable relationship between the unit bearing stresses developed and the permitted maximum—not over 20% of an arbitrarily assumed 3,000-lb cylinder strength, or 600 lb per sq in.

6. A rite religiously followed on the majority of construction jobs is the provision of "keys" in horizontal construction joints. The beam stem or wall may be narrow, perhaps only 6 or 8 in. wide, but "keys" of some form, 4 in. wide, 2 in. deep, must be provided at some definite spacing because it is so written. It may be that the concrete remaining at the side of the "key" is thin and of none-too-good quality because of the "key" but what of that? The inspector reads his precious specifications, clasps them to his bosom, and orders the "keys" put in. The brown wrapping paper of $B4$ suggests that the "keys" may just as well be eliminated. So likewise do the tests reported in the paper on "Shearing Strength of Construction Joints in Stems of Reinforced Concrete T-Beams," by Lewis J. Johnson and John R. Nichols, Members Am. Soc. C.E. (TRANSACTIONS, Am. Soc. C.E., vol. 77, 1914, p. 1499). A simple brooming of the joint surface to produce a fine-textured roughness will be far more efficient and far less costly than many a joint that has been made in the past decade with great physical difficulty and great mental anxiety.

7. An accompanying illustration clearly shows how compressive stresses develop at hooks. For such conditions are round bars with their greater wedging action as well adapted as square bars?

8. When it is generally recognized that the unit compressive strength of a standard 6-in. diameter cylinder 12 in. high, differs markedly from the unit strength of the same concrete tested in a cylinder of other dimensions—for example 12 in. in diameter and 6 in. high—why should it so generally be believed that the standard cylinder strength is the direct measure of the flexural compressive strength of concrete?

9. Test beams are usually narrow, slender members devoid of lateral restraint both at midspan and at supports. How representative then is their performance of that of beams in a monolithic bridge deck or building floor where lateral restraint exists?

These tests were made in the 300,000-lb machine in the laboratory of the engineering department of the City of Seattle. C. W. Wartelle is city engineer and B. B. Mason senior engineer in charge of tests. Thanks are due to both for their co-operation, also to the Northwest Steel Company of Seattle, which donated the reinforcing steel.

IMPRESSION OF SINGLE, 1-IN. BAR HOOK, END OF BEAM $B2$

Spalling at Lug Marks Shows High Compression on Concrete Inside Hook

Effects of Curvature in Supercritical Flow

Vertical Acceleration Components Modify Static Distribution and May Produce Pressure Drops Much Sharper than Those from Horizontal Curvature in Subcritical Flow

By Warren E. Wilson

Associate Member American Society of Civil Engineers
Head of Department of Mechanics, Colorado School of Mines, Golden, Colo.

The experimental work here described was carried out with the original intention of establishing principles to be used in the design of transitions for rectangular open channels. After some progress had been made, these aims were restricted to include only the experimental establishment of the fact that the subhydrostatic pressures did exist, and an analytical investigation of the effect of the non-hydrostatic pressure distribution, resulting from vertical accelerations of the liquid particles, on the depth change along the curved wall.

Essential features of the apparatus were a nozzle which permitted the introduction of a jet of water to a channel formed by a horizontal painted wood surface, a straight vertical piece of plate glass, and a vertical curved wall of sheet pyralin; a point gage which permitted the determination of the water depth between the walls; piezometers in curved wall and bottom; and a weir or calibrated nozzle for the determination of the quantity of water flowing.

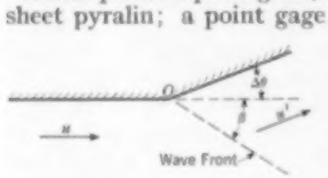


Fig. 1. Flow at a Diverging Wall

Pioneer work in the application of the analogy between the theory of supersonic gas flows and the supercritical flow of water was done by von Karman ("Eine praktische Anwendung...," *Zeit. f. Ang. Math. u. Mech.*, Vol. 18, pp. 49–56) and led to the establishment by Knapp and Ippen ("Curvilinear Flow of Liquids...," *Proceedings*, Fifth International Congress for Applied Mechanics, page 531) of an equation for the rise or fall of the water surface along a converging or diverging curved wall. Their assumption of constant velocity along the wall led to the following equation,

$$\frac{d}{d_o} = F_o \sin^2\left(\beta_o \pm \frac{\theta}{2}\right) \qquad (1)$$

where d is the depth of the liquid at the point along the curved wall at which the tangent to the wall makes the angle θ with the original direction of flow; β_o, the wave angle; $F_o = \frac{u_o^2}{gd_o}$, the Froude number; d_o, the depth; and u_o the average velocity, each at the beginning of the curve. The plus sign is used in connection with converging curved walls and the minus sign in connection with diverging walls.

At this time the peculiar characteristics of supercritical flow with hydrostatic pressure distribution might well be reviewed. Consider the flow, illustrated in Fig. 1, in which the liquid moves from left to right at velocity u and depth d, and is bounded on one side by the wall, the direction of which changes abruptly, at point O, by the amount $\Delta\theta$.

At point O the water surface will drop and this disturbance will be propagated outward from point O at a velocity c, relative to the water, where

$$c = \sqrt{gd} \qquad (2)$$

providing the disturbance is relatively small. It is to be noted that this disturbance cannot be propagated to the liquid upstream from the line marked "wave front," for the velocity u exceeds the wave velocity c. The angle made by the wave front with the direction of the velocity u is called β and is given by

$$\sin \beta = \frac{c}{u} \qquad (3)$$

After passing under the wave front the water will move parallel to the new direction of the wall and will have the velocity u' indicated in Fig. 1. There will be no change in the component of u parallel to the wave front, and the change perpendicular to the wave front will be proportional to the depth change experienced in crossing the wave front.

The assumption of a constant velocity enabled Knapp and Ippen to integrate the equation for the depth change and to obtain Eq. 1, which will be used as a basis of comparison for the results obtained in the ensuing discussion.

In Fig. 2 are shown the depths predicted by Eq. 1 and the observed depths under the conditions indicated. The corresponding pressure distributions along the wall and on the bottom at the beginning of the curves are indicated in Fig. 3. It was established by means of the experimental data that the differences between prediction and observation were not due to friction effects. The non-hydrostatic pressure was then investigated, since its existence was not in accord with the assumed conditions. The results of this investigation explained qualitatively the observed phenomena.

Non-hydrostatic pressure within the body of the liquid was characterized by a factor K in the following way. If the depth of the water is d, if m is the unit mass of the water, and if g is the acceleration due to gravity, then the total pressure on a vertical plane of depth d, extending from the surface of the water to the bottom, and of unit width, is given by P as follows:

$$P = K\frac{mgd^2}{2} \qquad (4)$$

The factor K is then the ratio between the total actual pressure and the hydrostatic pressure.

It might be well to emphasize at this point that, although reduction in pressure at diverging curved walls is also noted with subcritical velocities, such a reduction differs in two important respects from the change under discussion. With subcritical flow the reduction in pressure is associated with curvature of the streamlines in the horizontal plane, whereas that observed in supercritical flow is associated with curvature of the stream-

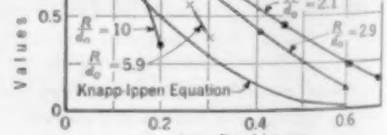


Fig. 2. Measured and Predicted Depths

lines in the vertical plane. Again, with subcritical flow, the reduction in unit pressure would be nearly uniform from surface to bottom since the curvature of the streamlines is the same at top and bottom in the horizontal plane. On the other hand, in the supercritical flow, sharp surface curvature indicates high vertical accelerations at the top and zero acceleration at the bottom. Consequently the relationship between unit pressure and depth below

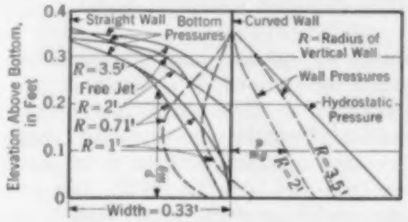


FIG. 3. WALL AND BOTTOM PRESSURES —VERTICAL SECTION AT CURVE

the surface is linear or nearly so for subcritical flow but is not so for supercritical flow.

While the characteristics of the flow with non-hydrostatic pressure distribution are in a general way the same as those of flow with hydrostatic pressure distribution, it may be shown, using the principle of conservation of momentum, that the expressions for wave velocity and wave angle are quite different from those previously described. Wave velocity is given by the equation,

$$c = \sqrt{gd\left(K + \frac{dK}{dd}\frac{d}{2}\right)} \ldots\ldots\ldots\ldots\ldots (5)$$

and the corresponding wave angle β is expressed as follows:

$$\sin\beta = \sqrt{\frac{gd}{u^2}\left(K + \frac{dK}{dd}\frac{d}{2}\right)} \ldots\ldots\ldots\ldots (6)$$

These expressions reduce to the corresponding ones for the hydrostatic pressure case, since the values of K and $\frac{dK}{dd}$ are now unity and zero, respectively.

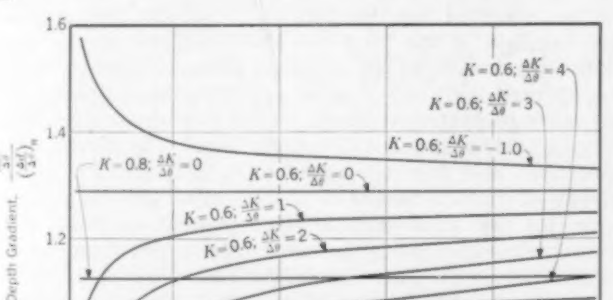


FIG. 4. VARIATION OF THE DEPTH GRADIENT RATIO WITH FROUDE NUMBER, CURVATURE, AND CHOICE OF K

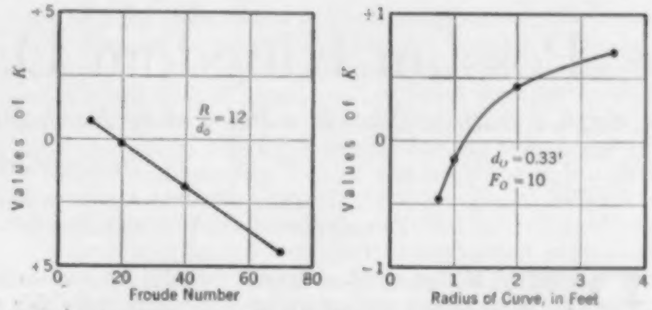


FIG. 5. INFLUENCE OF FROUDE NUMBER AND CURVATURE ON K AS DETERMINED EXPERIMENTALLY AT START OF CURVE

It may then be shown that the expression for the rate of change of the depth with respect to the angular change in direction of the wall is given by

$$\frac{dd}{d\theta} = \frac{d}{4K}\left(-\frac{dK}{d\theta} + \sqrt{\left(\frac{dK}{d\theta}\right)^2 + 16KF}\right) \ldots\ldots (7)$$

A corresponding equation for large values of F may be derived from the work of Knapp and Ippen:

$$\frac{dd}{d\theta} = F^{1/2}\, d \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

It is easily verified that for hydrostatic pressure distribution ($K = 1$, $\frac{dK}{d\theta} = 0$), Eq. 7 reduces to Eq. 8.

The integration of Eq. 7 has not yet proved feasible, but certain characteristics of the flow with non-hydrostatic pressure distribution may be determined by equating to unity the ratio between the quantity $\frac{dd}{d\theta}$ given by Eq. 8 and hereafter called the normal gradient, and $\frac{dd}{d\theta}$ as given by Eq. 7. For this condition, the gradient $\frac{dd}{d\theta}$ is identical for both hydrostatic pressure distribution and non-hydrostatic. The criterion for this condition is:

$$\frac{dK}{d\theta}\frac{1}{1-K} = 2\sqrt{F} \ldots\ldots\ldots\ldots (9)$$

Now if the combination of factors on the left-hand side of Eq. 9 is greater than $2\sqrt{F}$, the depth gradient will be less than the normal gradient. If the left-hand terms are less than $2\sqrt{F}$, the depth gradient is greater than normal.

In Fig. 4 is shown a graphical representation of the variation of the depth gradient ratio with the variables K, F, and θ. The qualitative verification of the variation of the depth gradient ratio is indicated by the experimental data shown in Fig. 2. In each case the initial depth gradient is flatter than would be expected with hydrostatic pressure distribution. This gradient gradually increases, becoming equal to the normal gradient and then, in the case of the longer radii, exceeding the normal gradient. However, no quantitative check on these depth gradients is possible at this time.

In Fig. 5 is indicated the variation, with the relative radius and the Froude number, of K, as measured at the beginning of the curve. It is apparent that large Froude numbers and short radii, relative to depth of water, contribute to the reduction in wall pressure, a factor to be considered in channel wall design. A given reduction in elevation of the water surface may be effected in a shorter distance with a diverging curved wall of the proper radius as a boundary than would be possible if the jet issued freely upon the horizontal surface.

Possum Kingdom Dam and Power House

Massive Buttress Structure Flanked by Earth Dikes Has Novel Construction and Design Features

By Charles P. Williams
Member American Society of Civil Engineers
Project Engineer, Ambursen Engineering Corporation, Mineral Wells, Tex.

SLABS and walls in a buttress dam, especially this one, are conceived on such a grand scale that the construction of similar elements in ordinary buildings becomes like watchmakers' work in comparison. Sliding joints for heavy pressures, tapered form ties 12 ft long, and seal coats for chemically unstable shale are a few of the special job details that make the description particularly instructive. Mr. Williams also presents a valuable record of temperature developments that should have a direct bearing on the design of massive walls in connection with a variety of other structures.

POSSUM Kingdom Dam is one of 13 proposed for construction in the development of the valley of the Brazos River, one of the most important rivers of Texas. It rises in the high plains of eastern New Mexico, flows through the semi-arid lands of the Panhandle, and discharges into the Gulf of Mexico at Freeport, about 55 miles south of Houston. Precipitation over the valley is irregular and undependable; long periods of very low flow are interrupted occasionally by large and flashy floods.

Sharing responsibility for the control of these natural conditions, the Possum Kingdom Dam is a concrete structure 1,610 ft in length with two earth-dike extensions of 630 and 380 ft. The normal elevation of the water surface in the reservoir, when full, will be 1,000 ft. This is 130 ft above the stream bed and 164.5 ft above the lowest foundation. The extreme top of the dam is El. 1,024, or 188.5 ft above lowest foundation. The reservoir, with water surface at El. 1,000, will have an area of 20,640 acres, and will impound 730,000 acre-ft.

Designs for the power house being constructed in connection with the dam, provide for three hydroelectric units having a total capacity of 30,000 kw, but it is proposed to install only two of them at present. Although the primary purpose of the dam is the generation of power, some protection against floods will be afforded. Also, regulation of the flow will facilitate irrigation in the lower Brazos Valley.

Studies made by the State Board of Water Engineers led them to the conclusion that the maximum unregulated flood at Possum Kingdom Dam site probably will not exceed about 325,000 cu ft per sec. With the control provided by the spillway gates, the outflow from the reservoir during such a flood in the opinion of the Board can probably be reduced to about 225,000 cu ft per sec.

Shale Saw Simplifies Foundation Stripping

The dam has been designed to resist the pressure created when the water surface is at an elevation of 1,015 ft. With the spillway gates lowered, and with a water-surface elevation in the reservoir of 1,000 ft, the estimated discharge is 90,000 cu ft per sec, and with a water-surface elevation of 1,015 ft, it is 280,000 cu ft per sec. The increase in storage between El. 1,000 and El. 1,015 is about 330,000 acre-ft.

At the site of the dam the geologic formation consists generally of nearly level strata of sedimentary rocks. These have an upper member of limestone and a lower member of shale and sandstone. The upper part of the shale and sandstone member has been oxidized by waters seeping through the overlying rock and its color has been changed from gray to yellow. The shale content has been changed to clay and the sandstone softened to such an extent as to be unfit for foundation purposes. In some places it was necessary to excavate this oxidized sandstone to a depth of 30 ft in order to reach suitable foundation material.

The concrete part of the dam rests on shale and sandstone. The shale, when dried and subsequently wetted, slakes and disintegrates rapidly. It was therefore necessary, after excavation, to protect the surface until it was covered by the concrete. In the specifications for the dam, it was provided that the shale, immediately after excavation to the required lines and grades, should be covered with one or more applications of an asphaltic or other protective coating, for the purpose of preventing drying and consequent disintegration. The specifications provided also that the engineer might require a certain depth of shale to be left in place temporarily as a protection for the final surface, this protective shale to be removed immediately before covering the final surface with concrete. The contractor was very successful in protecting vertical faces of the shale with an asphaltic sealing solution applied by spraying. Vertical cuts were made with a shale saw like that commonly used in coal mining. As the work progressed, the narrow channels made by the saw were filled with the fine, saw-cut shale chips to retard drying of the vertical shale surface. The fine material, with which the saw cut was filled, acted as a cushion to prevent the extension beyond the saw cut of shattering effects from the blasting.

Protection of the horizontal shale surfaces with the spray of asphaltic solution was found to be unsatisfactory because workmen walking in the area to erect forms and place reinforcing steel partially destroyed the coating. The shale surface disintegrated and, where there was water, became muddy, so that after reinforcing steel had been placed it was very difficult to clean the foundation area. The difficulty was finally met by first carrying the mass excavation to grade and later excavat-

ing rapidly 6 in. or more below grade and quickly backfilling with concrete to the established footing elevation. The foundation area then could be left without fear of deterioration until such time as it was desired to construct the buttress footing.

The Corps of Engineers, U.S. Army, investigated the site of Possum Kingdom Dam in 1936 and 1937, and made many tests to determine bearing values of the shale and sandstone. The resistance to shear and to sliding for concrete, both on the natural shale surface and on a shale surface treated with an asphaltic protective coating, was also evaluated. The tests were made at the Agricultural and Mechanical College of Texas, and at the Vicksburg Soils Laboratory of the Mississippi Waterways Experiment Station. Samples were taken from core borings made at the proposed site of the dam. Field tests made later on a larger scale were described in PROCEEDINGS for September 1939, by August E. Niederhoff, Assoc. M. Am. Soc. C.E.

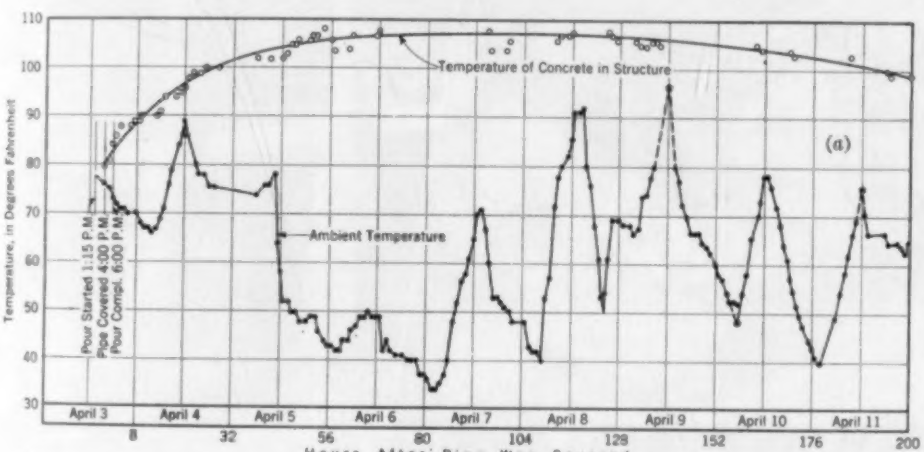
The concrete dam is of the Ambursen type and is made up of a spillway section 720 ft long, flanked by two bulkhead sections 325 ft and 565 ft long. The concrete structure in general includes a north abutment and 40 buttresses. The buttresses support an upstream deck whose slope is 8 horizontal to 10 vertical, and in the spillway part, a downstream deck of ogee section comprising crest slab, apron, and bucket. Water passing over the spillway will impinge upon a concrete hearth about 100 ft in width, at the downstream limit of which is a deflector wall having a continuous crest 8 ft in height above the top surface of the hearth.

Heretofore the spacing of buttresses in dams of this type has not exceeded 22 ft center to center. The spacing in the Possum Kingdom Dam is 40 ft, and the thickness of buttresses is correspondingly greater. The deck slabs also are necessarily thicker and heavier. The advantages in the massive buttress are reduction in the amount and cost of forms and increased stability against lateral deflection under water load. This makes a large amount of expensive lateral bracing unnecessary.

Design and construction of the deck for a buttress dam of the Ambursen type involve no special difficulty. The loads carried are very heavy, but the deck differs only in degree from an ordinary concrete slab supported on two opposite edges. The actual supports are haunches (brackets or corbels) poured integrally with the buttresses.

For a deck slab, the lower form is supported conveniently by beams and trusses, the ends of which rest upon the upstream faces of the buttress tongues, as shown in the photograph on the cover of this issue. Bolts, threaded at both ends and fitted with heavy plate washers, carry the load of the concrete supported by the under deck form, and that of the form itself, to the supporting beams or trusses. Obviously, these bolts cannot be removed until the deck slab has gained sufficient strength to become self-supporting. Means must also be provided to make this removal possible when the concrete has hardened. Pipe sleeves would be objectionable, but tapered bolts are simple and effective. These are coated with oil or grease before being embedded. When the concrete is about a day old, the adhesion between the bolts and the concrete is broken, one bolt at a time, by slightly loosening the nut at the small end of the bolt and striking that end several raps with a pneumatic hammer. The nuts are then tightened, first at the large end and then at the small end of the bolt. In this way the concrete is at no time left unsupported. After the slab has the required age, the bolts and forms can be removed. The tapered bolts used at Possum Kingdom Dam were 12 ft 6 in. long, the middle part being tapered for 7 ft from 2 in. in diameter to $1^1/_2$ in.

Bolt holes in the deck slabs must be filled carefully in order to prevent leakage under high heads of water. Mere filling with cement mortar is not sufficient. At Possum Kingdom Dam the bolt holes in the lower deck slabs were filled, beginning 34 in.



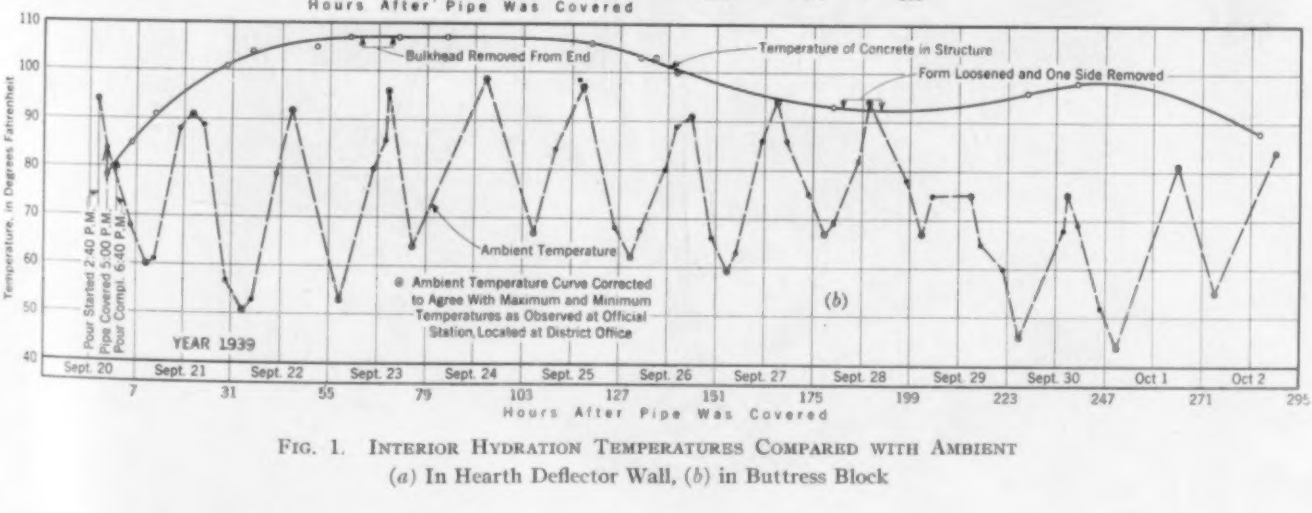


FIG. 1. INTERIOR HYDRATION TEMPERATURES COMPARED WITH AMBIENT
(a) In Hearth Deflector Wall, (b) in Buttress Block

TURBINE PENSTOCKS

(*b*) DOWNSTREAM ENDS OF SPILLWAY BUTTRESSES

(*c*) SHALE SAW AT WORK

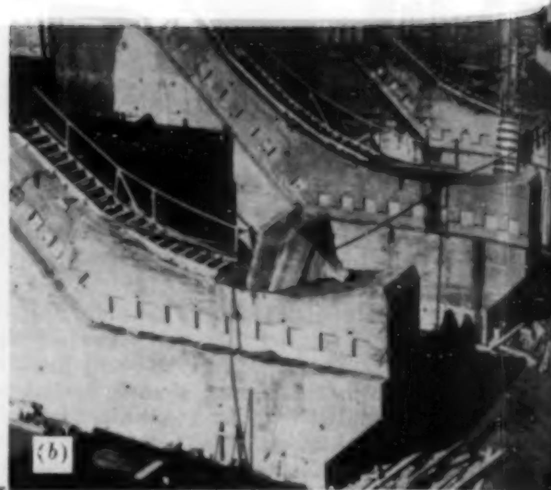
(*d*) CONSTRUCTION WITHIN THE FIRST COFFERDAM—VERTICAL CUTS VISIBLE IN SHALE AT LEFT CENTER

(*e*) THE NORTH ABUTMENT—STRUCTURAL STEEL ELEVATOR SHAFT FROM WALKWAY ON DAM TO TOP OF CLIFF

(*f*) INTRICATE NETWORK OF ELECTRICAL CONDUITS—MAIN FLOOR OF POWER HOUSE; REINFORCING STEEL ALMOST LOST IN MAZE OF TUBES

(*g*) TURBINE SCROLL CASES


(*a*)


(*b*)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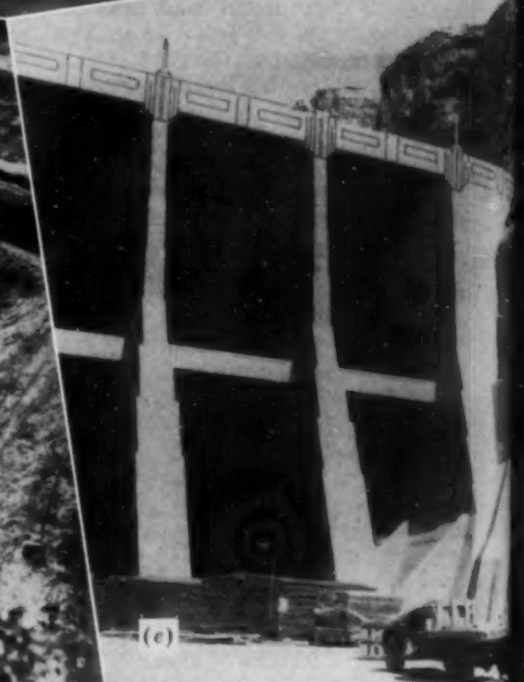
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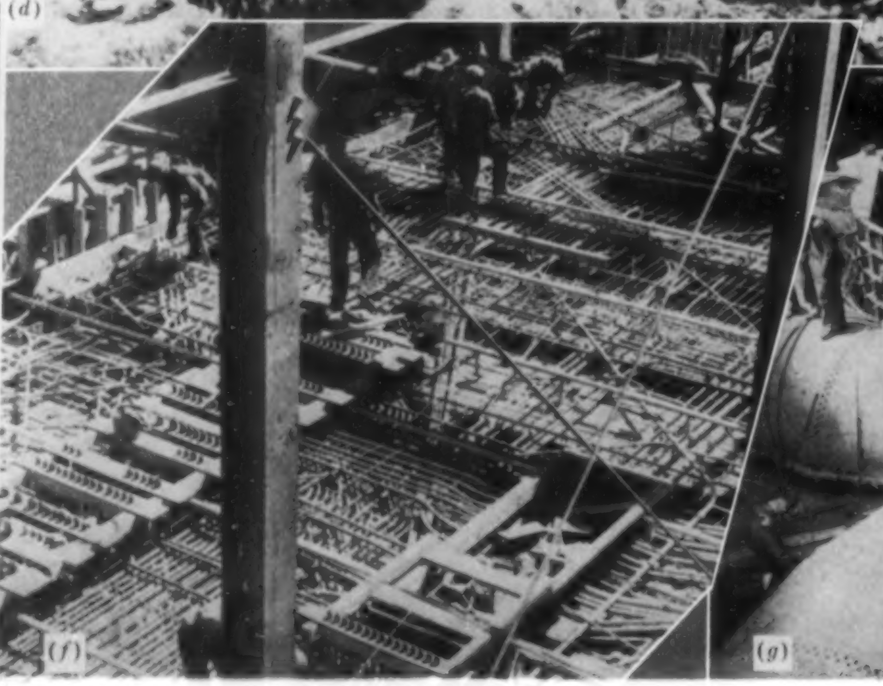
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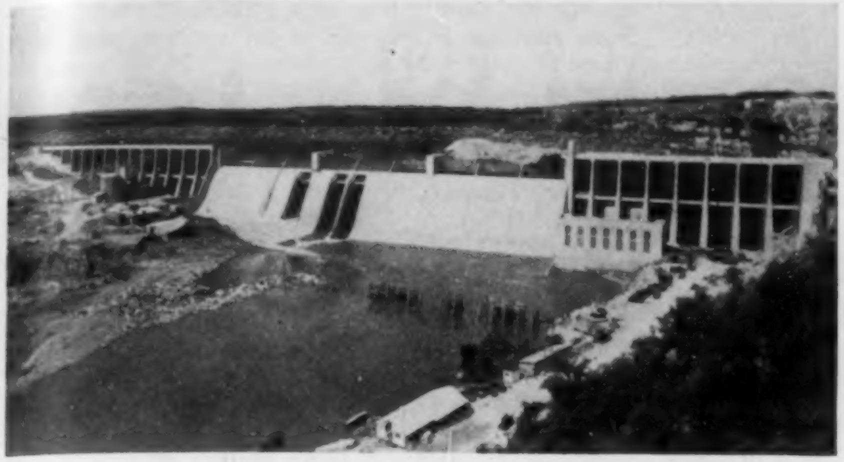


Nearly Completed—Three Diversion Openings Through Spillway Not Yet Closed

from the upstream face of the slab, with (1) a wooden plug 4 in. long, (2) cement mortar, dry mix, rammed into place to a depth of 6 in., (3) a wooden plug 4 in. long, (4) a bituminous plastic cement to a depth of 10 in., (5) a wooden plug 4 in. long, and (6) cement mortar, workable mix, 6 in. in depth.

A danger to be avoided in the design and construction of any buttress dam is cracking of the concrete in the buttresses. The cracking is caused principally by cooling from the high temperature produced during hydration. The probability of cracking can be reduced by avoiding high cement content and high water content; by continuous sprinkling for not less than two weeks, and preferably three weeks after forms are removed; by the use of low-heat cement; by pre-cooling aggregates and mixing water; and by employing contraction joints at intervals of not more than 35 or 40 ft.

CONTRACTION JOINTS ALONG STRESS TRAJECTORIES

In some buttress dams constructed within the last 15 years, the buttresses have been divided by contraction joints into curved columns, the joints being placed along the trajectories of the maximum principal stresses at the time of full reservoir. As illustrated in the photograph, the buttresses of the Possum Kingdom Dam are of this type, the maximum horizontal distance between joints being, in general, not greater than 35 ft. Low-heat cement and concrete of low cement content were used, the quantity of mixing water being limited to that necessary for securing good workability. During hot weather the water used in mixing was cooled by refrigeration; aggregates were cooled by spraying the tops of stock piles with water; and the concrete was sprayed with water for 14 days after placing. Data obtained from measurements of the internal temperature of each of two concrete blocks immediately following their construction are shown in Fig. 1. These temperatures were measured near the centers of the blocks.

The deflector, for which internal temperatures are shown in Fig. 1(*a*), is a wedge-shaped structure 40 ft long with a cross section varying in horizontal dimensions from 2 ft at the top to 19 ft at the base, and in height from 4 ft at its upstream face to 12 ft at its downstream face. At the time this block was constructed, the water-cooling plant had not been installed.

The buttress block for which internal temperatures are shown in Fig. 1 (*b*) was constructed at a time when the water-cooling plant was in operation. It has a length of 38 ft 6 in. at the bottom and 39 ft 9 in. at the top, a height of 12 ft, and a thickness of 9 ft.

Maximum temperature in each structure occurred about 3 or 4 days after construction. It will be seen from the chart that this was no higher in the buttress block than in the deflector block, notwithstanding the fact that the former was somewhat more massive and that, for the latter, the ambient temperatures after construction were generally higher, with consequent higher temperatures of the mixing water and aggregates.

The buttresses rest on broad footings so designed that the pressure on the foundation material does not exceed $5^1/_2$ tons per sq ft. They are built in 12-ft lifts. The bulkhead buttresses are 10 ft thick below El. 933, decreasing to 3 ft 6 in. at the top. The spillway buttresses are 9 ft thick below El. 933, decreasing to 8 ft at El. 957.

Probably the most critical feature of a buttress dam of the Ambursen type is the design of the haunches, or brackets, which support the deck slabs. The haunches are subject to heavy shearing stresses, and also to horizontal tensile stresses caused by contraction of the deck when cooled and the frictional resistance of the deck to sliding on the deck seat. For the lowest elevation of deck slab in the Possum Kingdom Dam, the load on the deck seat, at time of full reservoir for a distance of 1 ft along the seat, is 85 tons. For light pressures, the frictional resistance to sliding of concrete on concrete, with an intervening thin coat of plastic cement, is about one-third of the load. What the frictional resistance is under heavy pressures is a question. Assuming the coefficient to be one-third, the tensile stress in a 1-ft width of deck, when the deck contracts on cooling, will total $28^1/_3$ tons for the lowest deck slabs. For the purpose of design, the frictional resistance was assumed to be one-half of the load.

In certain tests made abroad by Dr. W. Humm, a low coefficient of friction for concrete on concrete was obtained by employing a 3-mm filler of asbestos cloth coated with mastic. The theory is that under very heavy pressures, the mastic alone probably would be squeezed out, whereas with the fibrous asbestos cloth, the mastic penetrates the interstices in the cloth and is held in place more securely.

In the Possum Kingdom Dam, the haunch seats are coated with (1) a thin coat of bituminous priming solution, (2) a coating of bituminous enamel, (3) a coating $^1/_8$ in. thick of bituminous plastic cement, (4) asbestos cloth $^1/_{16}$ in. thick, and (5) bituminous plastic cement $^1/_8$ in. thick. The bituminous preparations have a coal-tar base. A coating of bituminous plastic cement is used also between the end of the deck slab and the buttress tongue to prevent leakage.

Keyways are constructed in the buttress tongue to block downward creeping of the deck. If the deck slabs were free to slip downward on the haunch seat, a component of the deck weight would be transmitted to the foundation. The keyways ensure that the entire weight of the deck is transmitted to the buttress, a condition that produces more favorable stress relations. Premolded expansion-joint material was placed on the upper faces of the keyways in order to prevent crushing of the keys from expansion of the deck.

The crest of the spillway deck slab is of irregular section in order to conform to the spillway gates. The

apron varies in thickness from $2^1/_2$ ft to about 5 ft. The bucket is of two types, designated "high bucket" and "low bucket." In the "low-bucket" type the curved upper surface of the bucket terminates in a horizontal plane, coinciding with the surface of the hearth. In the "high-bucket" type, the curved surface continues past the low point, in order to discharge the water upward at an angle of about 18°. The hearth is 4 ft in thickness. It is anchored to the natural rock with $1^1/_4$-in. deformed bars, hooked at the upper end, extending into the rock 10 ft, and spaced in general at intervals of about 10 ft. At the downstream limit of the hearth is a deflector wall, whose top is 8 ft above the upper surface of the hearth, and whose base is at the elevation of the bottom of the hearth. Below the bottom of the deflector, a cutoff wall extends to a depth of 25 ft. A cutoff wall under the upstream limit of the concrete dam extends, in general, about 30 ft below the elevation of the buttress footings.

There are 9 spillway gates known as roof-weir gates. They are a modified bear-trap type, a Swiss invention covered until recently by patents of Huber and Lutz. Each gate is 73 ft 8 in. long and 13 ft 6 in. high. They are automatic and when in lowered position provide a free passageway for flood waters and drift.

In addition to the reservoir control afforded by the spillway gates, there is a high-pressure outlet, controlled by one 60-in. gate valve and one 54-in. horizontal cylinder valve.

Immediately downstream from the dam, near its north end, is the power house, which is of reinforced concrete about 144 ft long and 78 ft wide. Provisions have been made for three hydroelectric units, but for first development only two units are being installed. These will be vertical-shaft, single runner, Francis-type turbines, which will deliver approximately 17,000 hp when running at 171.4 rpm under a net effective head of 115 ft. Each turbine will be direct connected to a 12,500-kva, 60-cycle, 3-phase, a-c electric generator, with 6,900 v between phases, a speed of 171.4 rpm, and a power factor of 0.9.

Water will be delivered through the dam to each of the turbines through a 12-ft-diameter steel penstock 168 ft long. Between each turbine and the corresponding penstock is a 12-ft diameter motor-operated butterfly valve, with auxiliary manual control. At the intake to the penstocks is a 12 by 16-ft caterpillar gate, of track type, interchangeable between penstocks. The nominal operating head will be about 130 ft.

Each of the earth dikes has a crest width of 21 ft, with slopes of 3 to 1 on the upstream face and 2 to 1 on the downstream face. Limestone riprap laid on 12 in. of fine limestone chips protects the upstream face, the riprap being 18 in. thick at the crest and 3 ft thick at the base of the section of maximum height. Limestone chips to a depth of 18 in. cover the downstream face. The embankment was constructed of selected materials containing sufficient moisture to permit thorough compaction. It was spread in layers about 6 in. thick when completed, and was compacted with a sheepsfoot roller.

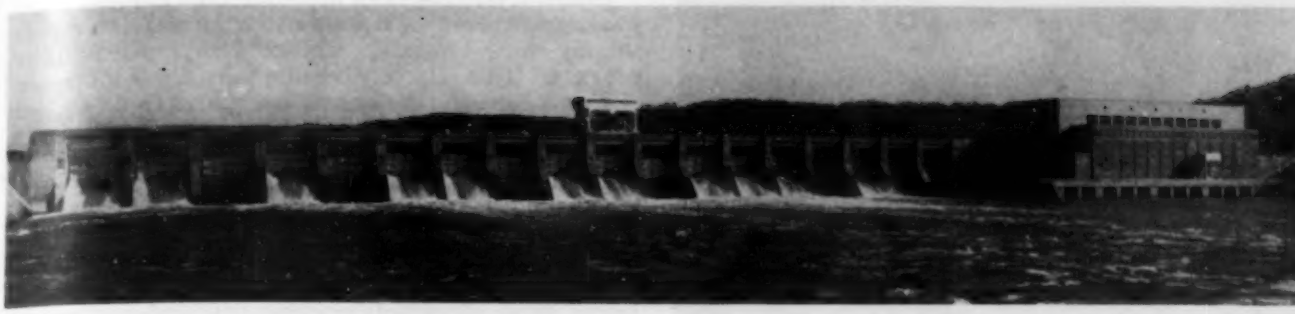
A reinforced-concrete core wall, in the plane of the upstream limit of the crest of the embankment, extends 5 ft into satisfactory underlying sandstone, and upward to 4 ft above the crest of the embankment. At the top it forms a parapet wall 4 ft higher than the parapet of the concrete dam.

Grouting holes were drilled in the stream bed along the upstream cutoff wall at intervals of 5 ft. Elsewhere along the cutoff wall of the concrete dam, they were drilled at intervals of 10 ft. In general the holes varied in depth from 25 to 80 ft. Pressures of 50 lb per sq in. were used. Very little grout was taken by the materials underlying the cutoff wall of the concrete dam, even where the material was sandstone. The sandstone underlying the earth dike, however, had more open seams and in a few cases took large quantities. One hole took nearly 4,000 cu ft.

Below the bottom of the core wall of the earth dike, grout holes were drilled through the sandstone at intervals of 5 ft to a depth of 60 to 65 ft at the maximum section, and extending in all cases into the underlying shale. They were bored in stages of about 15 ft. Each stage was tested with water to 50-lb pressure, and if not found tight was grouted before the boring of the second stage was begun. Grouting was continued until refusal under 50-lb pressure. Where more than a small amount of grout was taken, a mixture of cement and fine sand was used, the proportions varying with the conditions. In some cases as much as three parts of sand to one of cement was used.

The Possum Kingdom Dam and power house were built for the Brazos River Conservation and Reclamation District, of which John A. Norris, M. Am. Soc. C.E., was chief engineer and general manager, with headquarters at Temple, Tex. The designs were made and the construction was supervised by the Ambursen Engineering Corporation of New York, which was represented on the work by the writer. During the early part of the construction, L. H. Huntley, Assoc. M. Am. Soc. C.E., was construction engineer, and during the latter part, Henry F. Stubbs, Assoc. M. Am. Soc. C.E. The contractors were the C. F. Lytle Company of Sioux City, Iowa, and the Al Johnson Construction Company of Minneapolis. Oscar S. McCormick was general superintendent for the contractors and William H. De Butts, chief engineer.

SIDE VIEW OF A SPILLWAY BUTTRESS
Contraction Joints Follow Trajectories of Principal Stress



Guntersville Dam from End of Lock—Fixed Roller Gates Partly Raised

Waterways and Gates for Hydroelectric Plants

Improved Draft Tubes, Spillways, and Operating Mechanisms Show Influence of Laboratory and Analytical Development

By George R. Rich *and* Ross M. Riegel

Members American Society of Civil Engineers

Respectively Assistant Chief Design Engineer and Head Civil Engineer, Tennessee Valley Authority, Knoxville, Tenn.

Simpler and more rugged structures are the natural result of continued attention to practical construction methods and the requirements for efficient operation. Hydrocones and splitters have lost favor for draft tubes. Drastic reductions are being made in the number and variety of cranes, hoists, and miscellaneous hardware. Laboratory studies are gradually eliminating the causes of cavitation pitting. The paper was originally presented in more extended form before the Power Division at the Society's Cincinnati Meeting.

In recent years continued progress has been made on the design of waterways and gates for hydroelectric plants. Steady increases in size of generating units have been accompanied by sustained operating efficiency and simplification of scroll-case and draft-tube construction.

For the variable conditions of head and load that obtain at many low-head run-of-river plants, Kaplan turbines are ideally suited. On the other hand, where head and load conditions are fixed within fairly narrow limits, fixed-blade propeller turbines have been installed. The lowest turbine and generator costs are secured by setting the runner so far below minimum tailwater that the wheel diameter, and consequently the operating speed, are no longer dictated by cavitation requirements. In other words, the wheel diameter for such a low setting need only be large enough to furnish the required rated power output. On the other hand, minimum structural costs are generally obtained by keeping the runner as high as possible to reduce the amount of rock excavation and the hydraulic overturning load to be sustained. The optimum elevation of distributor will depend upon appraisal of the particular conditions for each individual project.

Contrary to an impression that appears to be prevalent, an increase in wheel diameter to provide more blade area and reduce cavitation does not arbitrarily impose a proportionate increase in unit spacing and waterway dimensions, both of which are solely functions of the discharge at the head for which best efficiency is desired. The only change necessary is a modification in the secondary pour of concrete behind the draft-tube liner to provide the correct transition from the runner to the remainder of the tube. In connection with the recent purchase of turbines for the Watts Bar Project, the wheel diameters submitted by the various manufacturers varied by as much as 18 in.; yet all manufacturers were entirely agreeable to bidding upon a common draft-tube and scroll-case design prepared in advance by cooperation of the bidders and verified by tests at each manufacturer's plant with his particular runner.

The basic structural design for the foundation of the typical low-head power station develops naturally from the characteristics of the propeller turbine. The entrance velocities at the intake are comparatively low—about 5 ft per sec for best modern practice—and consequently the intake structure may be relatively short, with simple waterway outlines designed essentially to give direction to the flow filaments entering the scroll case and to inhibit the formation of eddies at the trailing edges of the intermediate piers. On the other hand, the discharge velocity of the water leaving the wheel is comparatively high in proportion to the head, and has a high whirl component. A

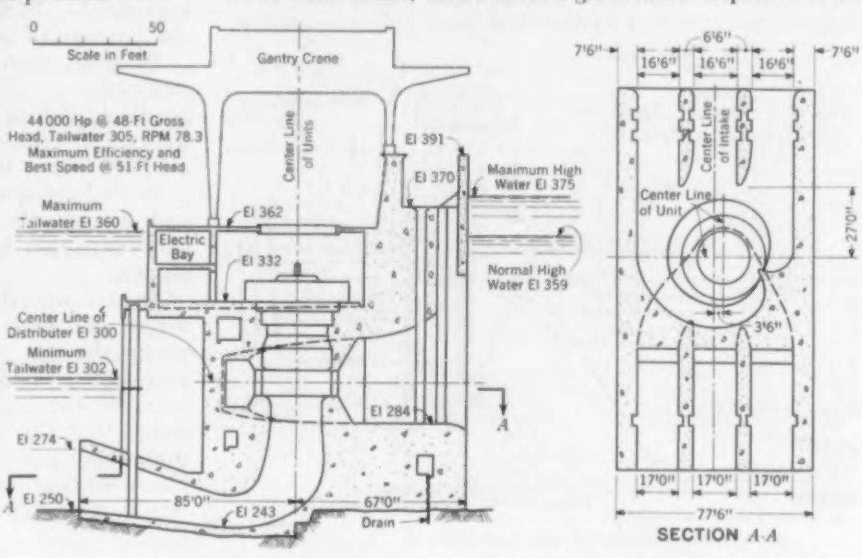
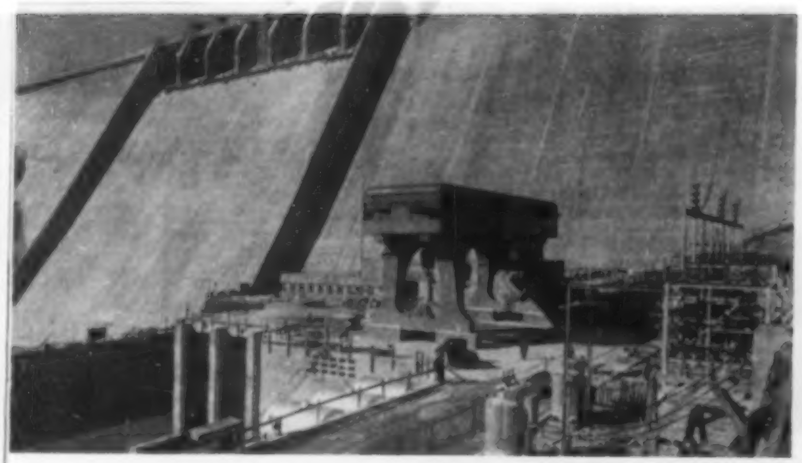


Fig. 1. Substructure Details for Kaplan Turbines, Kentucky Project



SPILLWAY, POWER HOUSE, AND CONTROL BUILDING—HIWASSEE DAM

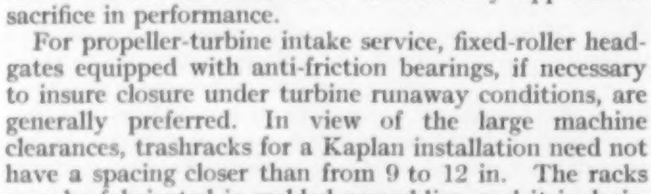
relatively high percentage of the total available energy is contained in the water passing the throat ring, and for satisfactory efficiency must be regained by a long, carefully proportioned draft tube. Maximum structural economy is obtained by designing the intake and draft tube as a monolith and utilizing their combined mass to sustain the hydrostatic overturning load. These principles are illustrated by the Kentucky power station shown in Fig. 1.

INTAKE DESIGNS FEATURE LOW HEAD LOSS, IMPROVED GATE DETAILS

The average well-designed propeller-turbine intake will show a head loss on the order of 0.2 ft, while the kinetic energy rejected to the tailrace will amount to a head loss of about 0.8 ft. The elbow type of draft tube shown in Fig. 1 has for some time been a standard feature of design for propeller turbine installations. In earlier plants designed by the Tennessee Valley Authority, draft tubes were provided with splitters, but because of the expense and difficulty of such construction and because of advances in tube design, it is now found feasible to omit these without any appreciable sacrifice in performance.

For propeller-turbine intake service, fixed-roller headgates equipped with anti-friction bearings, if necessary to insure closure under turbine runaway conditions, are generally preferred. In view of the large machine clearances, trashracks for a Kaplan installation need not have a spacing closer than from 9 to 12 in. The racks may be fabricated in welded assemblies, and it is desirable to employ for the constituent bars the standard round-edge sections carried in stock by the steel fabricators. It is understood that corrosion-resisting steel has been used to advantage in a plant troubled with acid water. In the Tennessee River plants, racks have been designed to sustain a hydrostatic head difference of 5 ft.

FIG. 2. SECTION THROUGH GUNTERSVILLE SPILLWAY



Design of waterways for moderate-head Francis turbine plants such as the Hiwassee development, contrasts sharply with low-head practice for propeller-turbine projects. This is largely because the mass of the power-station substructure is so small compared to the mass of the dam that, as a matter of practical design, the latter must be proportioned to sustain the entire hydrostatic overturning load. Structurally the scroll case and draft tube have the simple function of sustaining local hydrostatic pressures and the weight of the generating unit, entirely free from complications attending delivery of the reservoir overturning load to the foundation rock. Under these simplified requirements, and particularly in view of the higher hydrostatic pressures resulting from the increased head as compared with propeller plants, optimum structural efficiency is obtained by using plate-steel scroll cases and penstocks in waterways of circular cross-section to permit stressing the plates in hoop tension.

With reference to draft-tube design for the higher head plants, a velocity of 30 ft per sec at the throat ring, or a velocity head of 15 ft, represents but 8 per cent of the available head for a 200-ft plant compared with from 30 to 50 per cent for many propeller-turbine installations. In addition, the whirl component of the discharge is a much less troublesome influence in draft tubes for Francis turbines. A well-proportioned elbow-type tube, without splitters, hydrocones, or other auxiliaries, is now stand-

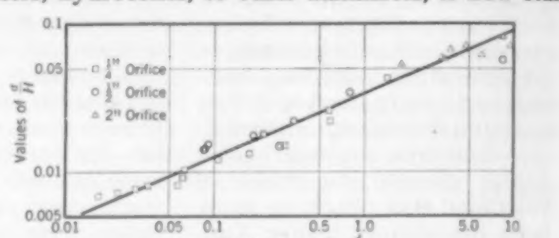


FIG. 3. ORIFICE, HEAD, AND PRESSURE RELATIONS FOR VENTILATION OF SPILLWAY GATES—PICKWICK LANDING PROJECT

ard practice for Francis turbines. For well-designed draft tubes, the head loss in the velocity of exit will be about 0.8 ft on the average.

In designing spillways for low-head, run-of-river developments on important streams, it is becoming increasingly necessary to make provision for multi-purpose functions such as navigation and flood control. In the case of projects constructed on erodible foundations, uniformity of flow distribution across the river channel is important. In many instances a design must anticipate the passage of ice during the early spring.

To meet such conditions, a wide range of types is available: (1) single gate leaves in each bay with overhead individual hoists supported by fixed towers of structural steel, (2) single gate leaves in each bay operated by heavy traveling gantry cranes, (3) roller drum gates of long span such as are used on navigation locks and dams on the Mississippi River, and (4) two or more gate leaves per bay operated by lighter traveling gantry cranes.

Type 1 affords minimum charges for operating personnel and may be justified in extremely cold climates where the use of lifting or grappling beams would be precarious. However, for weather conditions prevailing over the major part of the United States, it is believed that the initial capital cost and fixed charges for maintenance of the structural steel frame, heavy hoisting machinery, and electrical equipment for remote control would more than cancel the advantages.

Type 2 adds very materially to the cost of the spillway deck framing and hoisting equipment because of the greatly increased loads.

Type 3 is justified for lock and dam projects on rivers like the upper Mississippi, where exceptional width of opening between the piers is required to pass an enormous amount of ice or to accommodate floating trees or other heavy debris during major floods. Since the operating machinery is exceptionally heavy and rugged, this equipment is probably not warranted on any but a few of the very largest rivers.

Type 4, as adopted for the Guntersville Project (Fig. 2), has the advantage of lowest initial cost and annual maintenance charges. It provides all the flexibility needed without excess capacity.

AIR DUCT CAPACITIES ESTABLISHED IN LABORATORY

In connection with the determination of proper air vents to aerate the lower gate on the Guntersville spillway, some of the experiments that were made at the Hydraulic Laboratory of the Authority under the direction of George H. Hickox, M. Am. Soc. C.E., may be of interest. He used a suppressed sharp-edged weir 8 ft long and well calibrated. The sheet of water fell on a sloping face similar to the slope of the usual spillway. Discharges ranged from 2 to 30 cu ft per sec. The air admitted under the nappe was measured through $^1/_4$-in., $^1/_2$-in., and 2-in. orifices, and the pressure drop from the atmosphere to the space under the nappe was measured with a manometer. Maximum head on the weir was 1.06 ft.

The observed data were reduced to a unit length of weir by the relationship $d = \frac{D}{\sqrt{L}}$, where D is the orifice diameter used, d the corresponding orifice diameter for a 1-ft length of weir, and L the length. The data obtained (Fig. 3) suggest the dimensionless equation:

$$\frac{d}{H} = 0.0337 \left(\frac{d}{p}\right)^{0.429}$$

where H is the head of water on the weir in feet, and P the differential air pressure head between atmosphere and space under nappe, expressed in feet of water. The quantity of air required in cubic feet per second is given as $\frac{0.0000788LH^{7/2}}{P}$.

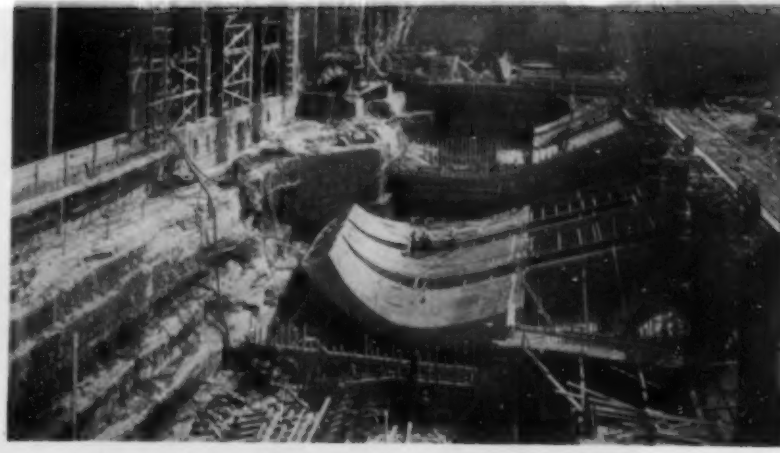
Knowing the quantity of air required and the allowable reduction of pressure under the nappe, the necessary diameter of opening can be computed by ordinary hydraulic formulas.

In these measurements differential pressures of as much as 9 ft of water were observed between the atmosphere and the space under the nappe, without entirely closing the vents.

FLOOD WAYS AND OUTLETS FOR HIGH-HEAD PLANTS

Higher-head hydroelectric projects on important streams frequently require two types of discharge facilities: (1) crest gates to accommodate floods without causing the reservoir surface to rise above a predetermined level, which is the upper limit of land acquisition, and (2) discharge outlets of relatively lower capacity situated in the bottom portion of the dam, for operation when the reservoir level is below the spillway crest, to discharge the flow necessary to meet the requirements of navigation or sanitation, or to avoid curtailment of the water supply for downstream power properties.

For high-head spillways in localities where ice conditions are not severe, radial gates are generally favored



DRAFT-TUBE AND TURBINE SUBSTRUCTURE AT GUNTERSVILLE

Basic Structural Design of Power Station Foundation Is Correlated with Hydraulic Design of Water Passages Through Close Cooperation Between Purchaser's Engineers and Manufacturer's Staff

because of their simplicity, ruggedness, and comparative ease of operation. However, for large, low-head, run-of-river projects, the necessary waterway area is generally so great that trunnion bearings for gates of the radial type would be prohibitively large, and more objectionable still, they would be submerged and subject to serious damage from debris during floods.

CAVITATION HAZARDS EVADED

In the design of high-head discharge outlets, the elimination of cavitation is a controlling consideration. If the outlet must be operated at partial opening, a balanced needle valve is probably the only kind that will be proof against destructive erosion. For controlling outlets that are to be operated fully open under all conditions, the ring-follower type of gate designed by the Bureau of Reclamation will give excellent service.

An interesting ring-follower installation is used on the Hiwassee Project. For the express purpose of inhibiting cavitation, the discharge conduit is given a straight, unbroken alinement from the carefully designed bellmouth entrance to the contraction or nozzle at the exit.

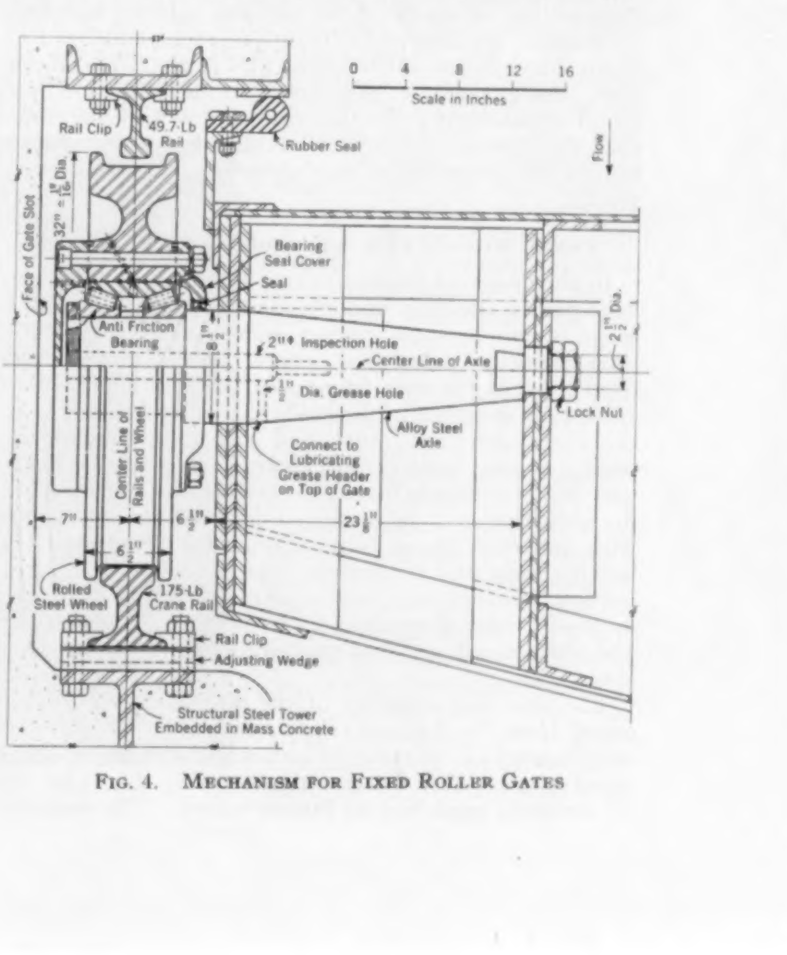
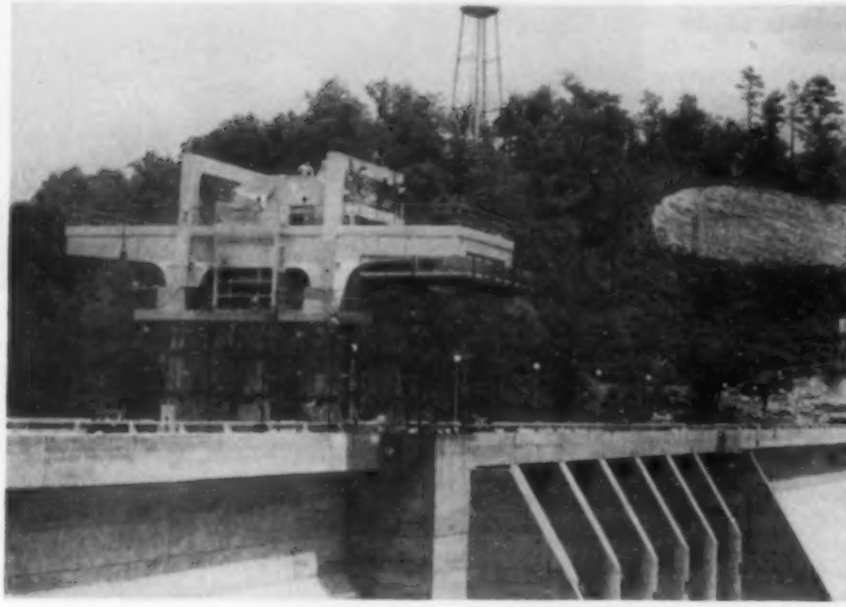


FIG. 4. MECHANISM FOR FIXED ROLLER GATES



SPILLWAY GANTRY SERVES RADIAL AND EMERGENCY GATES—HIWASSEE

The hydraulic gradient rises steeply at the nozzle, insuring a substantial positive pressure in the vicinity of the gate, where cavitation generally is most serious.

The form of bellmouth entrance was investigated by hydraulic laboratory tests conducted at the Carnegie Institute of Technology by H. A. Thomas, M. Am. Soc. C.E. The experiments were made in a vacuum tank to preserve as completely as possible the Froude scale ratio with reference to atmospheric pressure in the prototype. It was found that the bellmouth outline could in practical design be made appreciably smaller than the theoretical vena contracta without causing cavitation, thus affording a very desirable reduction in the size of the emergency gate required to close the entrance. Because the necessity of the vacuum method had been questioned, the form of bellmouth recommended by Professor Thomas was investigated also in the TVA laboratory, using positive pressures throughout, and was found satisfactory. In this connection it is suggested that the flow-net method is a valuable tool in proportioning the entrances to high-pressure conduits and penstocks.

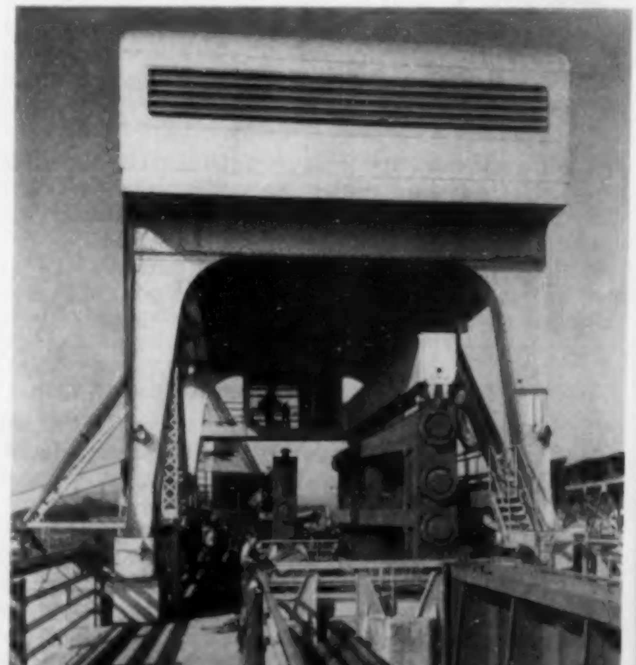
CRANE WHEELS REPLACE STONEY ROLLER TRAINS

In the design of headgates and spillway gates for low-head plants, the most important advance is the abandonment of cumbersome Stoney roller trains in favor of large-diameter rolled-steel crane wheels mounted on fixed axles in the gate frame and bearing on wide-head crane rails mounted in the guide slots. Depending upon the hydrostatic load sustained and the economic capacity of the hoisting machinery, the wheel bearings may be of the simple bronze-bushed type or of the sealed-in, anti-friction type designed for underwater service with pressure grease lubrication. With well-designed bearing seals and the proper type of grease, such anti-friction bearings are proof against corrosion. To give increased wearing qualities under heavy loads, both rails and wheel treads are heat-treated to a Brinell hardness of about 350.

The safe load capacity of the wheels may be determined from the formula, $P = 1{,}500\ DL$, in which D is the diameter of the roller in inches and L is the width of wheel tread. This figure compares with the value 500 DL formerly employed for Stoney rollers. The assembly shown in Fig. 4 is designed for an operating load of about 185,000 lb per wheel. Staunching rods and spring bronze seals of the older type have generally been supplanted by flexible seals of molded rubber. The so-called music-note shape shown in Fig. 4 combines the advantages of simplicity with a high degree of watertightness in service. The fixed seal plate on the face of the guide slot is so located as to induce a positive mechanical compression in the rubber seal strip, in addition to the sealing force afforded by the headwater pressure.

In conformity with the general trend in all steel structures, the basic design stress for gate construction has been advanced from 14,000 to 16,000 lb per sq in.; and in some instances where no adjacent welded details are required, the use of silicon steel in conjunction with a basic fiber stress of 24,000 lb per sq in. may prove economical. However, it is now the generally accepted practice to use welding as a means of attaching the gate skin plate to the supporting girders, since the area of the plate in the vicinity of rivet heads appears to be a focal point for progressive corrosion. Consequently the use of silicon steel is restricted to the downstream portions of gate frames.

In summary it may be said that advances in waterway and gate design are predicated upon more intensive use of rational analysis and laboratory model tests than heretofore. The continued use of such methods appears to be increasingly justified, provided that the resulting trend in design is in the direction of greater simplicity and ruggedness, better performance, and improved economy. Costs of development work of this kind are generally less than the cost of trial and error at full scale.



CRANE LIFTS SPILLWAY GATES AT CHICKAMAUGA DAM

William Mulholland—Engineer, Pioneer, Raconteur

Part I. His Start in Life and His Service in the Los Angeles City Water Company

By J. B. Lippincott

Honorary Member American Society of Civil Engineers

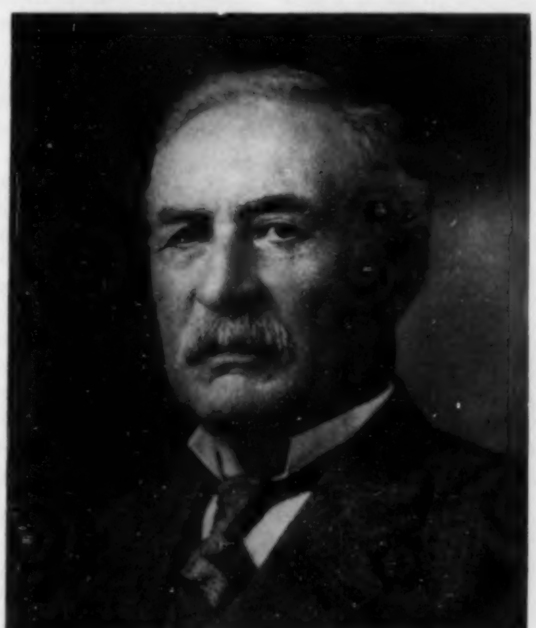
Consulting Engineer, Los Angeles, Calif.

The material for this biographical sketch was contributed or collected by the members of the Mulholland Memoirs Committee appointed by the Los Angeles Section of the Society. As chairman of that committee Mr. Lippincott prepared the sketch, to appear in two parts, of which this is the first. The other members of the committee were Rose Mulholland (Mr. Mulholland's daughter), H. A. Van Norman, W. W. Hurlbut, George Read, J. E. Phillips, D. A. Lane, and Thomas Brooks. All are grateful for this opportunity not only to secure a more general recognition of Mr. Mulholland's great contributions to the development of Southern California, but also to express their personal respect and admiration for one who was a great man as well as a great engineer.

It is the year 1861. In a small house on the coast of Dublin, Ireland, three people are sitting, two men and a small boy. The boy listens with rapt attention to the conversation of the two men. Great names come up in the conversation —Gladstone, Disraeli, Lincoln, Victoria, Bismarck. Discussion touches on the ever present Irish question, the great Civil War in the United States (Ft. Sumter has just been fired upon), the Parlimentary controversy in England. The boy hears, and a great desire is born in his consciousness to accomplish something worth while for his fellow men, an ideal that was never to leave him.

The men are discussing the recent voyage of one of them, a sea captain, over the trade routes of the British Empire. The boy listens to the account of the journey. Love of the sea is an instinctive part of his being and a sailing vessel to him is a lovely, living thing.

Seven years later, at the age of 15, William Mulholland shipped before the mast, sailed the turbulent Atlantic for four years, and disembarked at New York in 1874. During his first trip across the Atlantic the captain, pleased by his interest in navigation, instructed him in it and allowed him to plot the course of the ship. On arrival in New York he was less than fifty miles off. He never lost his love of the sea and even up to within a few months of his death, when asked where he would like to drive, he would reply, "The Los Angeles harbor."



William Mulholland, 1855–1935

The next scene is in Cincinnati, Ohio, in 1875. A discouraged young man of twenty walks aimlessly down the street. He has just been discharged from the hospital after a threatened leg amputation. He is thousands of miles from home, without a job, and has only a few dollars in his pocket. Still weak from his severe illness he is too proud to let his people know of his plight. "What is the use of making another effort—nothing but grinding work with no reward," he thinks. Then he hears the strains of *Gloria in Excelsis* sung by a boy choir in a church he happens to be passing, and a flood of renewed hope and courage sweeps over him.

After he landed in New York, Mulholland sailed the Great Lakes in the summer of 1874, and worked in Michigan lumber camps the following winter. There he received the leg injury that has been referred to. During his recovery he became attached to an itinerant mechanic with a team, who drove through the country sharpening scissors and repairing clocks. Mulholland grew so fond of this gypsy life that he had to force himself to give it up. But the urge to do something worth while that drove him on all through his life asserted itself once more.

Next he worked in his uncle's dry-goods store in Pittsburgh, Pa. While there he read a book that had a great influence on his later life—Nordhoff's *California*. His interest in that fabulous land was so aroused that shortly after his twenty-first birthday he and his brother set sail from New York for Colon, Panama. They walked the 47 miles across the Isthmus to save the $25 railroad fare. From the City of Panama they sailed as members of the crew of a ship bound for Acapulco, Mexico, whence they took another ship to San Francisco. After a few days in the romantic city, they started for the San Joaquin Valley, the beauties of which were so vividly portrayed in Nordhoff's book. They rode down the valley on horseback to what was then the little Spanish pueblo of Los Angeles (with less than 5,000 inhabitants). Surrounded by vineyards and citrus groves, through which meandered the small willow-banked river which was later to play such an important part in Mulholland's life, it so impressed him that he determined to make this region his home. Near the little town of Compton on the outskirts of Los Angeles he began his long career in water supply work by digging artesian wells with a hand drill. Later he installed the first water system for the village—now the city of Long Beach.

The following winter months the two brothers spent prospecting near Erhenberg, Ariz., and there Mulholland first saw the Colorado River, which 45 years later he was instrumental in

utilizing as a new source of water supply for Los Angeles. Apparently no great strikes were made on this trip for near the mouth of the Bill Williams River they turned their burros loose and floated down the Colorado to Ehrenberg on a log and brush raft. At one time, running short of grub, they went into the lonely cabin of a prospector who sold a few staple groceries as a side line. Finding no one at home, they took the needed supplies and left the money for them on the table. They then departed down the river.

An interesting sequel to this prospecting trip was provided by an incident that took place in 1924. Mulholland was in Parker, Ariz., on a preliminary survey trip for the diversion of Colorado River water Sitting in the hotel lobby one night, he had just told the story of this prospecting trip to a group of local people when one of the old-timers spoke up, "Well, it has taken a long time to find out whose tracks those were. I have wondered for many years who came to that cabin." It seems that the owner of the cabin had been murdered and his wife had fled to the hills with her baby. It was between the time of the murder and her return to the cabin with a posse that Mr. Mulholland and his brother had stopped there. The brother of the murdered man, a member of the posse, had picked up the trail of the murderer, followed it into Mexico, caught up with his man and brought him back into the United States for trial. This is but one of many amazing adventures that marked Mulholland's remarkable life.

FIRST JOB WITH THE LOS ANGELES CITY WATER COMPANY

After this prospecting trip he returned to Los Angeles and went to work in the spring of 1878 for the Los Angeles City Water Company, one of the companies that had a franchise to supply the city. At first he lived in a cabin at what is now the intersection of Los Feliz Boulevard and Riverside Drive. By his cabin he planted an oak which is now a fine tree. Here really began what later developed into one of the most unique and successful careers of professional and public service that a man could wish for. It is here that a memorial fountain to Mulholland was erected in the spring of 1940, by public subscription.

The old Zanja Madre (mother ditch) ran along a side hill a few feet above the river road. On his first job for the company Mulholland worked in this ditch. He was down in the bottom of the ditch throwing out large

PLAZA OF LOS ANGELES ABOUT 1890

shovelfuls of dirt and weeds when William Perry, president of the company, drove by. Impressed by this workman's energetic performance, he stopped and called to him in a rather peremptory way, asking him who he was and what he was doing. Mulholland looked over the side of the ditch and replied that it was none of his questioner's —— business. Perry let it go at that and went on to town. Some of the other workmen then came up and told Mulholland he had been addressing the president of the company. Mulholland stopped work, put on his coat, and went into town to the office to "get his time" and quit before he was fired. Perry was at the office ahead of him, but instead of paying him off he made him foreman of the ditch gang. Mulholland referred to this incident as his first recognition in the Los Angeles City Water Company, to the head of which by his ability and energy he rapidly rose.

The original pueblo of Los Angeles was founded by the Spanish as a base for the troops that occupied California. In the pueblo there was a community of ownership of both land and water, which persisted until the transfer of the government of California to the United States in 1850. Thereafter the community-held pueblo lands were distributed and a period of real estate speculation was inaugurated. Fragments of the old public lands remain in Elysian Park and Pershing Square, which never have been transferred from the original title made under the Spanish crown. The most important property of the pueblo, however, was the river, the communal ownership of which has been ever since retained. This public ownership of the water was always defended as a sacred trust even against the missions, because the life of the town depended upon it.

In 1868, after the United States occupancy, a 30-year franchise was granted to the Los Angeles City Water Company to serve what was then a pueblo of 5,000 people. The consideration for the franchise was a small fountain in the old Plaza. Diversion of river water was limited to 150 miners inches (3 cu ft per sec) and this diversion permit never was extended by the City Council.

George Read, the head of the city water meter division, is one of the few remaining members of the "old guard" who were associated with Mulholland during his period of service with the private water company. He tells the following anecdote of those early years: "The Chief was always resourceful,

HOLLYWOOD RESERVOIR AND MULHOLLAND DAM, LOOKING OVER THE MODERN CITY OF LOS ANGELES

fearless, and never flustered in a pinch. When anything out of the ordinary happened he was generally the first to speak and would say the right thing in a witty manner. One evening he invited Fred Fisher and me to have a 'smile' before going home. At the time I was driving a one-seated Oldsmobile acquired when we took over a small water system in the western part of the city. The Chief called it a 'one-lunger.'

"As I was driving around the Plaza, a tall lanky fellow riding a bicycle approached us. I honked the horn and, not getting the fellow's attention, applied the brakes. I had just about stopped when he banged into the front of the car. The bicycle stopped but the man came on over the dashboard and landed all sprawled out across our feet. While I was wondering whether the man might be hurt, the Chief looked down at him and said, 'What the devil are you doing in here?' The man looked up at him with a bewildered expression, crawled out of the car, picked up his bike, saluted the Chief, and rode away without saying a word. We had two 'smiles' instead of one.

"I shall never forget the hunting and fishing trips that it was my good fortune to spend with the Chief. I can see him now, sitting by the campfire, smoking his pipe, and telling us about his boyhood experiences and the things he had observed in different parts of the country. I was always interested in hearing him tell about the various rock formations because he could see sermons in such things. I know that in being associated with him I learned to think more deeply, to appreciate more fully the wonders of nature, and to see the humorous side of life."

PERSONAL CHARM COMBINED WITH SOLID VIRTUES

Mulholland's inimitable style and zest in the telling of stories gave them a charm that cannot be reproduced on paper. It is the difference between a wild flower growing in its natural environment and a painted one.

Another tribute to him comes from Thomas Brooks, the superintendent of distribution for the Los Angeles Water Company. In a letter concerning Mulholland he states:

"His advice to the employees under his immediate supervision was, 'When the whistle blows, shut and lock the office door, leaving all worries and shop troubles behind that locked door. Then go home and have a pleasant time with the family, remembering never to cross your bridges until you get to them.' For years, during the time he was chief engineer for the Water Department of the City of Los Angeles, he had the confidence of the citizens of the entire city almost as a unit. The local politicians recognized the powerful following he had and as a result the department was free from political interference. The citizens stood back of him because they recognized in him a thoroughly dependable and honest man, beyond the average in ability as an engineer and a true friend of their city."

During his fifty years of service to the people, Mulholland achieved by foresight and dynamic leadership a distinction unprecedented in the history of water development and water works construction. Keeping pace with his city of adoption, realizing its potentialities, anticipating its needs, he brought about in his lifetime, by the construction of one of the largest and most unique water systems in the world, the development of a mere village into the fifth largest metropolis in the United States. From an original distribution system containing 3 miles of wooden pipe, 1 mile of small iron pipe and a single reservoir with a capacity of less than 10 acre-ft, the system grew to comprise more than 3,800 miles of pipe and 65 reservoirs and tanks capable to storing more than 160,000 acre-ft of water at the time of his death, July 22, 1935. Most of this was conceived and completed during his last thirty years of service, and was in itself an achievement that probably will never be duplicated.

WILLIAM MULHOLLAND MEMORIAL FOUNTAIN, ON LOS FELIZ BOULEVARD AT RIVERSIDE DRIVE
Dedicated August 1, 1940

While Mulholland was largely self-educated, in his manhood he was surprisingly well informed on a great variety of subjects. His memory was phenomenal. He was frequently called upon to act as a consultant by various municipalities and corporations in California.

At one time he was testifying before the State Railroad Commission on behalf of certain water users in Marin County, California. The water company was seeking to establish high values for its plant in order to justify its water rates. It claimed a cost of 80 cents per cu yd for building its earth dam. Mulholland testified that 50 cents was a fair value. On cross examination he was asked: "Now, Mr. Mulholland, considering the location of this dam and all the surrounding difficulties of construction, would you not think it might reasonably have cost 80 cents per cubic yard?" "Well," answered Mulholland, "if you had had a parcel of old women, carrying that dirt up on the dam in their aprons and stomping it down with their feet, it might have cost 80 cents per cu yd."

A FORMIDABLE OPPONENT ON THE WITNESS STAND

W. B. Matthews served the City of Los Angeles in various legal capacities and was Special Attorney for the Department of Water and Power for many years. To hear Matthews and Mulholland in court was a joy. Both belonged to the same old school. They had worked together on so many cases that Matthews would only have to ask a general question, and during Mulholland's long ensuing answer he would proceed with the studying of his notes with no apparent attention to what Mulholland was saying. When he would realize by the final silence that Mulholland had finished, he would look up and ask another question. Mulholland's answers in many of the earlier cases are gems of information on the early history and hydrology of the Los Angeles area and are frequently referred to, to this day. On cross-examination Mulholland was at his best. Seldom was there need for his attorneys to object to an irrelevant question for it usually let the interrogator in for trouble. The Chief's keen Irish wit would usually turn the attack into a striking point for his side, or else subject his opponent to his ridicule.

Being cross-examined at one time as an engineering expert he was asked by an attorney who sought to embarrass him: "Will you please tell us what preparation you had when you started out in the world on your own account?" With an Irish twinkle in Old Bill's eyes he answered, "I learned the Ten Commandments and had my mother's blessing."

Profiles for Spectator Sight Lines

Methods of Determining Seating Elevations for Theaters and Stadiums

By C. A. Holden

Member American Society of Civil Engineers

Chief of Design, Fraser-Brace Engineering Company, Inc., Wilmington, Del.

In the design of spectator facilities, such as auditoriums and grandstands, one of the most important considerations is to give each spectator a good view of the "zone of interest," that is, the picture, play, game, race, or whatever it is he is there to see. He must be placed so that he can see the zone of interest without obstruction by other spectators in front of him. This may be accomplished by two methods: (1) by raising the zone of interest above the level of the spectators' eyes, as in lecture rooms, churches, etc., or (2) by placing the spectators so that each is at a higher level than those in front of him, as in grandstands. Or a combination of both methods may be used, as in movie theaters.

The first method is effective and economical only for a comparatively small number of spectators viewing a comparatively small zone of interest; for all other cases use must be made of the second method. The problem then becomes one of determining how much higher each spectator must be placed than those in front of him. This means fixing the sight-line profile, which may be defined as the profile of the eyes of the spectators in a vertical plane passing through the critical point of the zone of interest. The critical point is the last point seen by the spectator above the spectators in front of him as his line of sight moves downward, and is here called the sight point; it is usually the lowest or nearest point in the zone of interest. It follows, of course, that if a spectator can see the sight point he can see the whole zone.

If the zone of interest is comparatively narrow, as in theaters and boxing rings, a spectator may get a satisfactory view between the heads of spectators close in front of him, and it then becomes necessary to give him a view only over the heads of spectators two or more rows in front. On the other hand, if the zone of interest is wide or shifts rapidly from side to side, as in outdoor stadiums or amphitheaters, then it becomes necessary to give the spectator a view over the heads of those immediately in front of him. In certain cases, such as large movie theaters, the more distant spectators may get a satisfactory view between heads immediately in front while those nearby would require a view over all heads in front of them.

The vertical clearance of a line of sight above the eye of a spectator in front is called the eye clearance and is intended to provide for the space occupied by the upper part of the head (and sometimes also a hat); its value is usually taken from 3 to 6 in. The smallest value, 3 in. is suitable for use indoors where no hats are worn; outdoors the higher values are applicable. It is obvious that any such figures can only represent averages and that it is not feasible to provide a clearance that will insure a good view under all circumstances to every one of the spectators.

The fundamental relations between any two adjacent eye points on a sight-line profile may be illustrated by Fig. 1, in which SP is the sight point; E and E' are the eye points; a is the eye clearance, the minimum value of which is fixed by the foregoing considerations; and b is the "tread dimension," the value of which is fixed by considerations of comfort and economy. (But if eye clearance is provided only over the second or third row in front, then b equals two or three times the tread dimension.)

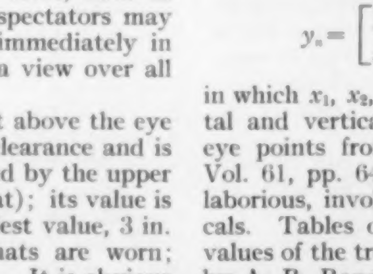


Fig. 1. Eye Points on a Sight-Line Profile

As the location of the nearer eye point with respect to the sight point is usually fixed, the height of the farther point is given by the following equations obtained from a consideration of similar triangles:

$$h = \frac{b(y + a)}{mb} = \frac{y + a}{m} \quad \ldots\ldots\ldots\ldots (1)$$

$$R = h + a \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$y' = y + R \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

If the location of the farther eye point is fixed, the value of h may be found from

$$h = \frac{by'}{mb + b} = \frac{y'}{m + 1} \quad \ldots\ldots\ldots\ldots (4)$$

With these equations any sight-line profile may be determined from any one eye point whose location with respect to the sight point is fixed, by computing the height of every other point progressively. The computation can readily be made in tabular form with slide-rule solutions of Eq. 1 or Eq. 4. This procedure becomes laborious, however, when a large number of rows of spectators is involved, especially if, as often happens, several possible profiles must be investigated for a single project. It is evident also that, with a a constant, every value of R will be different, and the profile will become a curve of ever-changing slope, with resulting complications in the construction of the floor or deck, which must of course be located a uniform distance below the spectators' eyes.

Another much used form of equation, readily derived from the foregoing relations, is

$$y_n = \left[\frac{y_1}{x_1} + a\left(\frac{1}{x_1} + \frac{1}{x_2} + \ldots \frac{1}{x_{n-1}}\right)\right] x_n \quad \ldots\ldots (5)$$

in which $x_1, x_2, \ldots x_n$, and $y_1, y_2, \ldots y_n$ are the horizontal and vertical distances, respectively, of the several eye points from the sight point (*Engineering Record*, Vol. 61, pp. 64 and 741). The solution of this one is laborious, involving as it does a summation of reciprocals. Tables of summation of the reciprocals for two values of the tread dimension, 30 in. and 32 in., prepared by A. B. Randall and E. S. Crawley ("The Design of Seating Areas for Visibility," *The American Architect*, May 21, 1924), reduce considerably the labor of using the formula and are especially useful for preliminary studies in which only a few controlling points of the profile need to be determined, and in which the tread dimension is either 30 or 32 in. Tables prepared by M. W. Serby ("Stadium Planning and Design," *The Architectural Record*, February 1931)

for the same purpose are of more general application but may involve serious interpolation errors.

Practical considerations of economy and simplicity usually lead to the adoption of an approximation to the precise ideal profile with a constant eye clearance throughout. In these approximations the eye clearance is kept at or above a fixed minimum value; the resulting profile is thus slightly steeper than the ideal and its average eye clearance is slightly larger.

One method of approximating the ideal is to make changes in the slope of the profile only at points that are certain fixed distances apart. This method is well adapted to use with floor slabs laid directly on the ground, and with floors or stepped decks supported by structural steel framing. In this case the relations between the controlling points of the profile are illustrated by Fig. 2, in which E and E' are eye points at adjacent locations where changes in the slope occur.

With the location of E fixed, the height of E' is given by the following equations, again based on similar triangles:

$$h = \frac{b(y + ga)}{mb} = \frac{y + ga}{m} \qquad (6)$$

$$R = h + a \qquad (7)$$

$$y' = y + gR \qquad (8)$$

For extending the profile down from E, the equation is

$$h' = \frac{by}{mb} = \frac{y}{m} \qquad (9)$$

The use of the latter equations is illustrated by the following example:

Given: The eye of a spectator in the first row of an auditorium 30 ft horizontally from, and 12 in. vertically above, the sight point near the front of the stage, a minimum eye clearance of 4 in. over the second row in front, a tread dimension of 36 in., and breaks in the profile at intervals of 18 ft. Then

$y_1 = 12$ in.; $a = 4$ in.; $b = 2 \times 3$ ft $= 6$ ft; $gb = 18$ ft; $g = \frac{18 \text{ ft}}{6 \text{ ft}} = 3$; $ga = 12$ in.; $y_1 + ga = 24$ in.; $m_1 b = 30$ ft; $m_1 = \frac{30 \text{ ft}}{6 \text{ ft}} = 5$; $y + ga = y + 12$ in.; $R = h + 4$ in.; $y' = y + 3R$.

The computation is then carried on in tabular form:

EXAMPLE 1

Row	m	y (In.)	3R (In.)	y + 12 in. (In.)	h (In.)	R (In.)
1	5	12		24		
			26½		4.8	8.8
7	8	38½		50½		
			31		6.31	10.31
13	11	69½		81½		
			34½		7.41	11.41
19	14	104		116		
			37		8.29	12.29
25	17	141		153		
			39		9.00	13.00
31	20	180				

Procedure: 1. On the first line set down the values of m_1, y_1, and $y_1 + ga$ given above.

2. On the second line set down the values of h' and R computed from Eqs. 6 and 7 and the value of $3R$ to the next higher multiple of ½ in. (or multiple of ¼ in. or less, if greater accuracy is deemed necessary).

3. On the third line set down 7 in the "Row" column and 8 in the m column (that is, the values fixed by the 18-ft interval between breaks in profile), 38½ in the y column (= 12 in. + 26½ in.) and $y + 12$ in. = 50½ in.

4. On the fourth line set down values of h, R, and $3R$ computed as before but based on the value of $y + 12$ in. in the third line. (It is evident that each value of y' becomes the value of y for the succeeding computation.)

5. Continue until the last row is reached.

The eye clearance for any critical row may be checked by Eq. 9. Thus for Row 25,

$$h' = \frac{y}{m} = \frac{141 \text{ in.}}{17} = 8.30 \text{ in.}$$

$$R = \frac{37 \text{ in.}}{3} = 12.33 \text{ in.}$$

$$a = R - h' = 4.03 \text{ in.}$$

This type of computation goes rapidly, especially with slide-rule solutions of Eq. 6, which are usually amply accurate.

Another method of approximating the ideal sight-line profile is to vary the riser heights (R in Fig. 1) by uniform increments (such as ¼ in., ½ in., 1 in.), making a

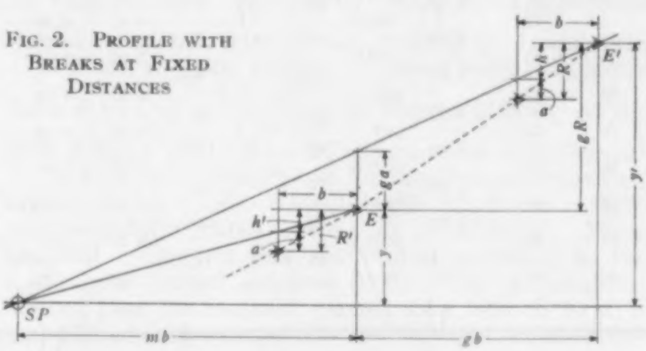


FIG. 2. PROFILE WITH BREAKS AT FIXED DISTANCES

change only where necessary to maintain the fixed minimum eye clearance. This method is well adapted to concrete construction. In this case let c be the uniform increment of riser heights; then in Fig. 2,

$$c = R - R' = h - h'$$

but from Eqs. 6 and 9,

$$h - h' = \frac{y}{m} - \frac{y + ga}{m}$$

$$\therefore c = \frac{ga}{m}$$

$$\text{or } g = \frac{mc}{a} \qquad (10)$$

Likewise it can be shown that for a profile extending down from E the next point of change in riser height may be located by the following:

$$g' = \frac{mc}{a + c} \qquad (11)$$

It is evident that with this method the eye clearance for any spectator will be between a and $a + c$.

The use of Eq. 10 in conjunction with Eqs. 1, 2, and 3 in the determination of profiles of this type is illustrated in the following problem:

Given: The eye of a spectator in the first row of a stadium 50 ft horizontally from, and 39 in. vertically above, the sight point on the ground outside the football gridiron, a minimum eye clearance of 4 in. over the row

next in front, a tread dimension of 25 in., and all riser heights to be multiples of $^1/_2$ in. Then

$y_1 = 39$ in., $a = 4$ in. min., $b = 25$ in., $m_1 b = 50$ ft $= 600$ in.

$$m_1 = \frac{600 \text{ in.}}{25 \text{ in.}} = 24,\ c = 0.5 \text{ in.},\ g = \frac{mc}{a} = \frac{0.5m}{4} = \frac{m}{8}$$

The requirement that all riser heights be multiples of $^1/_2$ in. and the fact that the actual value of a is usually something more than the minimum introduce occasional errors in the value of g as computed from Eq. 10, but any such errors may be quickly found from Eq. 9, and the necessary corrections made, as described below. The following tabular form may be used:

EXAMPLE 2

Row	m	h (In.)	y (In.)	gR (In.)	g	R (In.)	h' (In.)	a (In.)
1	24		39					
		(1.79)		(18)	(3)	(6)		
(4)	(27)		(57)				(2.11)	(3.89)
				12	2	6		
3	26		51				1.96	4.04
		2.12		19 1/2	3	6 1/2		
6	29		70 1/2				2.43	4.17
		2.57		28	4	7		
10	33		98 1/2				2.98	4.02
		3.10		30	4	7 1/2		
14	37		128 1/2				3.47	4.03
		3.58		32	4	8		
18	41		160 1/				3.92	4.08
		4.01		42 1/2	5	8 1/2		
23	46		203				4.42	4.08
		4.50		54	6	9		
29	52		257				4.94	4.06
		5.02		66 1/2	7	9 1/2		
36	59		323 1/2				5.48	4.02
		5.55		70	7	10		
43	66		393 1/2				5.97	4.03
		6.02		84	8	10 1/2		
51	74		477 1/2				6.45	4.05
		6.51		99	9	11		
60	83		576 1/2				6.95	4.05

Procedure: 1. On first line set down the values of m_1 and y_1, given above.

2. On second line set down value of h (1.79 in.) computed by Eq. 1 using the minimum value of $a = 4$ in.; set down the value of R (6 in.) which is the nearest multiple of $^1/_2$ in. above the value of $h + 4$ in. (5.79 in.); set down the value of g (3) computed from Eq. 10; set down the value of gR (18 in.).

3. Add gR (18 in.) to y_1 (39 in.) to get $y_4 = 57$ in.; add g (3) to m_1 (24) to get $m_4 = 27$.

4. Test the eye clearance at Row 4 by Eq. 9 which gives $h' = 2.11$ in., hence $a = 6$ in. $- 2.11$ in. $= 3.89$ in., which is too small; therefore strike out lines 2 and 3 (the figures shown in parentheses) and start again on the fourth line with $g = 2$, $R = 6$ in., $gR = 12$ in.

5. Add new values of g and gR to m_1 and y_1 to get values of m_3 and y_3 and test eye clearance at Row 3 by Eq. 9, which gives $h' = 1.96$ in. Hence $a = 6$ in. $- 1.96$ in. $= 4.04$ in., which is above the minimum.

6. Repeat these operations for each new value of g, as indicated.

It may be noted that after the height of the first riser is found, it is not necessary to compute the value of h by Eq. 1 again, but it is useful to do so as its value gives a clue to whether the larger or the smaller whole-number value of g should be used when g does not come out a whole number by Eq. 10.

The formulas and procedures entered here are obviously susceptible to many variations and adaptations. If many profiles having the same minimum eye clearance and the same increment between successive riser heights are to be determined, the construction of a diagram will be useful. The methods described were developed by the writer in the office of Gavin Hadden, M. Am. Soc. C.E.

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Partially Restrained Structural Members

By W. N. SUOMINEN, JUN. AM. SOC. C.E.

PHILADELPHIA, PA.

ALTHOUGH the Hardy Cross method[1] of moment distribution has been widely used in the solution of statically indeterminate structures, it has generally been applied only to structures whose columns or girders were either fixed or hinged at the supporting ends. However, this method may easily be extended to the solution of frameworks containing partially restrained members by modifying the nominal stiffnesses, the nominal carry-over factors, and the nominal fixed-end or applied moments of the partially restrained members.

Since the Cross method is so well known, only a brief description of the nominal properties of structural members will be attempted. For prismatic members whose ends are fixed, the nominal stiffnesses, K, and the nominal carry-over factors, CO, are equal to $4EI/L$ (or proportional to $4I/L$, I/L, etc.) and to $^1/_2$, respectively, and the nominal fixed-end or applied moments, F, may be obtained from the usual formulas. For members of variable section whose ends are fixed, the nominal stiffnesses, nominal carry-over factors, and nominal fixed-end or applied moments may be obtained from the Portland Cement Association charts,[2] Ruppel's tables,[3] Hickerson's tables,[4] or others.

A partially restrained member is one that has an end which is neither fixed nor hinged, but which is partially fixed. The degree of restraint, f, varies between 1 (fixed) and 0 (hinged). The girder AB in Fig. 1 (a) is fixed at A and partially restrained at B. The modified stiffness at A, MK_A, of the member AB is equal to $(3 + f_B)/4$ times the corresponding nominal stiffness. The modified carry-over factor from A to B, MCO_{AB}, is equal to $4f_B/(3 + f_B)$ times the corresponding nominal carry-over factor. It should be noticed that the stiffness at B and the carry-over factor from B to A do not change.

If a nominal end moment is induced at the partially restrained end B of the member AB, part of the moment is retained at B and some of the remainder is

carried across to A. The portion that remains at B is the modified end moment at B, MF_B. The modified end moment at A, MF_A, is the sum of the nominal end moment at A and the moment that is carried across from B. Since the induced moments at both ends of a member may rotate in the same direction (caused by settlement of a support) or in opposite directions (caused by transverse loading), different expressions for the modified end moments are obtained.

The expressions for the modified end moments of these two cases are given in Figs. 1 (*b*) and 1 (*c*). The

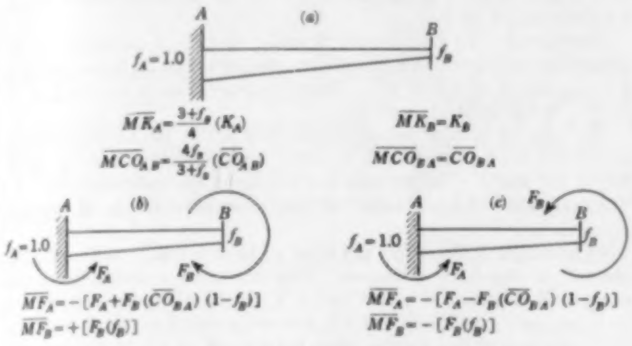


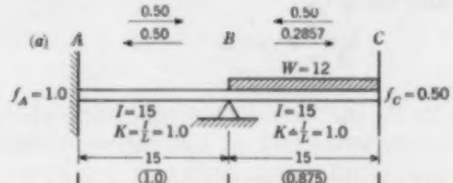
FIG. 1. BEAM VALUES MODIFIED FOR PARTIAL RESTRAINT

(*a*) Physical Constants, (*b*) Moments Induced by Transverse Loading, (*c*) Moments Induced by Settlement of a Support

moment sign convention used is plus for clockwise rotation and minus for counterclockwise rotation. Therefore, if the directions of the induced moment rotations are opposite to those shown, the signs before the brackets are changed accordingly.

The procedure to be used in the solution of a structure containing partially restrained members is about the same as that used in the usual Cross method. The nominal stiffnesses, nominal carry-over factors, and nominal end moments for all the members are first determined. Then the necessary modified values for the partially restrained members are found and substituted for the corresponding nominal values. A partially restrained end may now be considered fixed, because all the moment that is carried across to it remains there. The usual moment distribution process is then followed for the remainder of the analysis.

The continuous beam[4] in Fig. 2 (*a*) has been selected as an example because it illustrates fully the application of moment distribution to partially restrained members, and because the results may be compared with those of



(*b*)

0	0	−18.75	+ 7.50	Modified Induced Moment
0	+10.00	+ 8.75	0	Distribute
+5.00	0	0	+ 2.50	Carry-Over
0	0	0	0	Distribute
+5.00	+10.00	+10.00	+10.00	Total

FIG. 2. EXAMPLE OF CONTINUOUS BEAM WITH PARTIAL RESTRAINT

the Hickerson method. The nominal stiffnesses for spans AB and BC are both 1.00, but the modified stiffness for span BC is $\frac{3 + 0.5}{4}$ (1.00) = 0.875. The nominal carry-over factors from A to B, from B to A, and from C to B are all 0.500, but the modified carry-over factor from B to C is $\frac{4(0.500)}{3 + 0.500}$ (0.500) = 0.2857. At the ends B and C of the span BC, the nominal end moments ar -15.00 and $+15.00$, but the modified end moments are $-[(15.00) + (1 - 0.500)(0.500)(15.00)] = -18.75$ and $+[(0.500)(15.00)] = +7.50$, respectively. These modified values are then distributed according to the usual Cross method, as shown in Fig. 2 (*b*). It should be noticed that the moment carried over from B to C is $(0.2857)(+8.75) = +2.50$.

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Relation of Reynolds' Number R to Manning's *n*

By ROBERT E. KENNEDY, M. AM. SOC. C.E.

DENVER, COLO.

IT is frequently of interest to those working with pipe friction factors involving Reynolds' number, **R**, to find its equivalent in the more familiar Manning's n. For this purpose the three factors, f in $H_f = \frac{fLV^2}{D2g}$, n in $V = \frac{1.486R^{2/3}s^{1/2}}{n}$, and $\mathbf{R} = \frac{VD}{\nu}$, can be directly related in a single equation which lends itself readily to the construction of a simple alinement chart like that shown in Fig. 1.

To the many advantages of using the Manning formula may be added the fact that it can also be converted into the friction coefficient, λ, with which Reynolds' number is usually plotted. This is equivalent also to Darcy's f, and is essentially the same as the Weisbach, Chezy, or Fanning friction factor.

Figure 1 shows the relationship between Reynolds' number, Manning's n, and Darcy's f in an alinement chart in which **R** is reduced to a velocity of 1 ft per sec to simplify the computations, and kinematic viscosity, ν, is fixed at a mean temperature of 59 F. Other velocities and viscosities are a matter of simple arithmetic, since they are both straight-line functions of Reynolds' number.

The kinematic viscosity for temperatures between 32 and 85 F is readily found in standard reference tables.

The nomograph also shows that temperature has an influence, though small, on Manning's n. For instance in Example 3, which follows, a change of water temperature from 59 to 33 F decreased n from 0.017 to a little less than 0.016.

The mathematical relationship of these functions is simplified by the fact that Darcy's f and Manning's n

can be solved simultaneously to eliminate both s and V. The resulting equation is

$$R = \frac{(10.8\, n)^6}{f^3} \quad \text{.......(1)}$$

Substituting this in the Reynolds number equation eliminates D and leads to

$$\frac{\mathbf{R}}{V} = \frac{(13.6\, n)^6}{\nu f^3} \quad \text{.......(2)}$$

Inserting 1.23 for the value of the kinematic viscosity at 59 F, and using a velocity of 1 ft per sec yields the equation

$$\mathbf{R} = \frac{5.16\, n^6\, 10^{11}}{f^3} \quad \text{.......(3)}$$

which is plotted in Fig. 1. Equation 3 is not difficult but it requires more time to solve than to lay a straight-

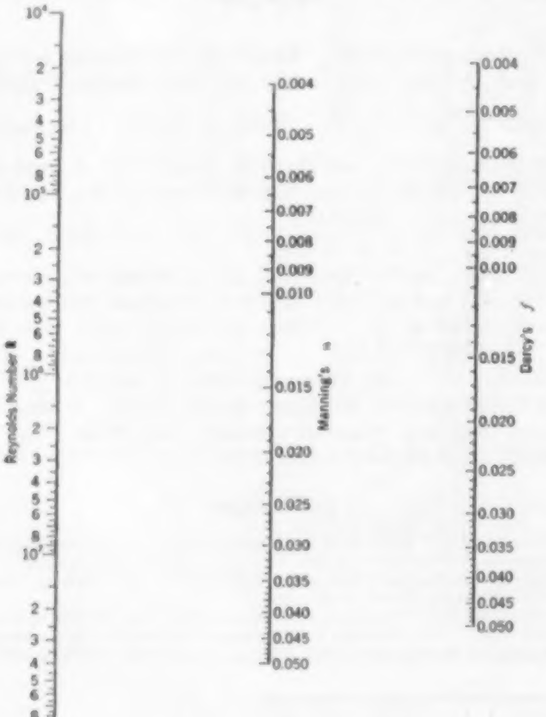


FIG. 1. NOMOGRAPH OF **R**, n, AND f

For Water in Pipes and Open Channels at Temperature of 59 F and Velocity of 1 Ft per Sec

edge on the figure. A nomograph for any velocity and any water temperature may be made by the addition of two more columns to Fig. 1. Such a chart was constructed but it seemed more roundabout to use than to solve the two simple arithmetical operations involved by hand.

Example 1. To find **R** with f and n given. A structure is designed for $n = 0.014$, $f = 0.020$, and a velocity of 5 ft per sec, no water temperature given. What is **R**?

On the chart a straight line from $f = 0.020$ through $n = 0.014$ cuts the **R** column at 5.0×10^6. This is for a velocity of 1 ft per sec. Then **R** for 5 ft per sec is 2.5×10^6 at an assumed water temperature of 59 F.

Example 2. To find n with **R** and f given. A structure is observed to have $f = 0.018$, a velocity through it of 20 ft per sec, and a computed **R** of 4.0×10^7. Water temperature is assumed to be 59 F. What is Manning's n?

If a velocity of 20 ft per sec has an **R** of 4.0×10^7, then a velocity of 1 ft per sec has an **R** of 2×10^6. A straight line between $\mathbf{R} = 2.0 \times 10^6$ and $f = 0.018$ cuts the n column on the chart at 0.017.

Example 3. To find effect of water temperature on Manning's n.

In Example 2 the water is found to have a temperature of 33 F instead of the 59 F assumed. This increases ν and reduces the computed **R** from 4.0×10^7 to 2.6×10^7 for the given velocity of 20 ft per sec. A velocity of 1 ft per sec would have an **R** of 1.3×10^6. A straight line on the chart between $\mathbf{R} = 1.3 \times 10^6$ and $f = 0.018$ cuts the n column at about 0.0157 instead of the 0.017 previously found.

While the equation of the nomograph was developed primarily for full circular pipe sections, it may be applied to open-channel conditions to ascertain an **R** based on the idea that the diameter of a pipe, D, is a parameter equal to $4R$ of an open channel.

NOMENCLATURE

- $\mathbf{R}$ = Reynolds' number, non-dimensional
- V = mean velocity through cross section, in ft per sec
- D = diameter, in ft = 4 times hydraulic radius for full circular section
- R = hydraulic radius, in ft
- ν = kinematic viscosity, in ft² per sec
- f = friction factor in Darcy formula, in ft per sec, also known as λ
- H_f = total head lost in energy grade, in ft
- λ = f
- L = length of section, in ft
- s = $\frac{H_f}{L}$ = slope in ft per ft of energy grade, or slope of water surface if flow is uniform
- g = acceleration due to gravity = 32.2 ft per (sec)²
- n = friction factor in Manning formula, in (sec)² per ft

Horsepower Chart for Spur Gears

Convenient Nomograph Solves Formulas in Movable-Bridge Specifications

By E. G. PAULET, ASSOC. M. AM. SOC. C.E.

BRIDGE DESIGNER, STATE DEPARTMENT OF HIGHWAYS, BATON ROUGE, LA.

ACCORDING to the Standard Specifications for Movable Highway Bridges (1938), of the American Association of State Highway Officials, in the design of spur gears the permissible tooth load is to be determined from the formula

$$W = SPfy \quad \text{.......(1)}$$

in which W = permissible tooth load, in lb
S = permissible fiber stress, in lb per sq in.
P = circular pitch, in in.
f = face width of gear, in in.
y = a factor depending upon the number and form of the teeth

The permissible fiber stress, S, on a gear tooth is limited by the formula

$$S = S_B\left(1 - \frac{1}{4{,}200}\sqrt{6{,}200V - V^2}\right) \quad \text{.....(2)}$$

in which V is the velocity at the pitch circle of a gear, in ft per min. Two of the values specified for S_B are, for Class C forged-steel gears, $S_B = 22{,}000$ lb per sq in., and for cast-steel gears, $S_B = 20{,}000$ lb per sq in. Values of y for two much-used forms of gear teeth are, for 20° involute stub teeth (Nuttall system, pinion with not less than 14 teeth),

$$y = 0.178 - \frac{1.033}{N} \qquad (3)$$

and for 20° involute standard teeth,

$$y = 0.154 - \frac{0.912}{N} \qquad (4)$$

In these formulas N is the number of teeth on the gears.

The application of Eqs. 1, 2, and 3, or 4, can be much simplified by using a nomograph, which will give results sufficiently accurate for most practical purposes.

The nomograph shown in Fig. 1 gives the solution of Eqs. 1 to 4, and the horsepower rating of the gear. The

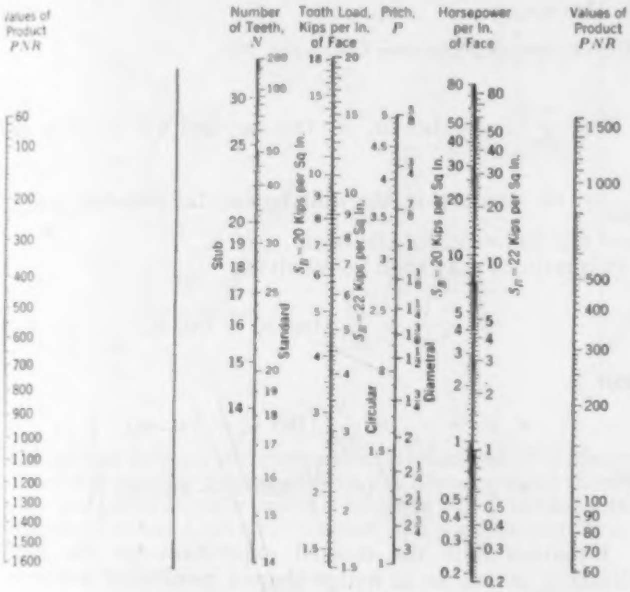


FIG. 1. HORSEPOWER CHART FOR 20° INVOLUTE STUB AND STANDARD CUT-TOOTH GEARS

horsepower scale facilitates the choice of gears once the horsepower of the prime mover is known. The nomograph has been prepared for gears whose velocities at the pitch circle are, in general, less than 150 ft per min. This is usual when the machinery is connected to the prime mover through a gear reducer.

The derivation of the equation for the horsepower scale may be of interest. First, Eq. 2 is rearranged:

$$S = S_B\left(1 - \frac{V}{4{,}200}\sqrt{\frac{6{,}200}{V} - 1}\right) \qquad (2a)$$

For velocities of less than 150 ft per min at the pitch circle of the gear, the omission of the number 1 under the radical sign of Eq. $2a$ will introduce an error of less than 1% in the value of S. This simplification leads to

$$S = S_B\left(1 - \frac{V}{4{,}200}\sqrt{\frac{6{,}200}{V}}\right) = S_B\left(1 - 0.01875\ V^{1/2}\right) \qquad (2b)$$

The pitch diameter being $D = \dfrac{NP}{\pi}$, the circumference at the pitch circle is $\dfrac{\pi D}{12}$, in ft, or $\dfrac{NP}{12}$. If we let R represent the number of revolutions per minute, then the velocity V, in ft per min, is

$$V = \frac{NPR}{12} \qquad (5)$$

Substituting this value in Eq. $2b$ yields

$$S = S_B\left(1 - 0.01875\sqrt{\frac{NPR}{12}}\right)$$
$$= 0.005413\ S_B\left(184.7 - \sqrt{NPR}\right) \qquad (2c)$$

Introducing the value of S from Eq. $2c$ into Eq. 1, and letting f equal unity, we obtain for a gear face of 1 in.,

$$W = 0.005413\ S_B\left(184.7 - \sqrt{NPR}\right) Py \qquad (6)$$

Now the horsepower equals

$$\frac{\text{Work done per min}}{33{,}000} = \frac{WV}{33{,}000} = \frac{WNPR}{33{,}000 \times 12} \qquad (7)$$

Therefore, substituting in Eq. 7 the value of W from Eq. 6, and using the values of y from Eqs. 3 and 4, we obtain, for 20° involute stub teeth, horsepower equals

$$0.005413\ S_B\left(184.7 - \sqrt{NPR}\right)\left(0.178 - \frac{1.033}{N}\right)P\frac{NPR}{396{,}000} \qquad (8)$$

and, for 20° involute standard teeth, it equals

$$0.005413\ S_B\left(184.7 - \sqrt{NPR}\right)\left(0.154 - \frac{0.912}{N}\right)P\frac{NPR}{396{,}000} \qquad (9)$$

Use of the nomograph is illustrated in the following example:

Find the face required for a forged-steel pinion fastened on the low-speed shaft of a gear reducer.

Data: 7½-hp electric motor, 830 rpm, full load speed, connected to the high-speed shaft of the gear reducer, which has a 123:1 ratio. Efficiency of reducer assumed at 95%. S_B = allowable for forged steel = 22 kips per sq in. Pinion to have 14 teeth, 20° involute standard cut.

By A.A.S.H.O. specifications, the face of the pinion should lie between a 1.5 circular pitch and 3.0 circular pitch. The circular pitch should, in general, be not less than 2 in. The pinion is to be designed for 150% overload.

First Solution: The normal load is increased 50% and used to find the face width. Try pinion

$$\left.\begin{array}{l} P = 2.51 \text{ in. circular pitch} \approx 1^1/_4 \text{ diametral pitch} \\ R = \dfrac{830}{123} \approx 6.75 \\ N = 14 \text{ teeth} \end{array}\right\} PNR = 237$$

f = 1.5 circular pitch = 1.5 × 2.51 in. = 3.77 in. min

The horsepower equals 7.5 × 95% × 150% = 10.7, and the horsepower per inch of face $= \dfrac{10.7}{3.77 \text{ in.}} = 2.84$

From the chart, the horsepower is obtained as follows:

Beginning at the extreme left scale of the nomograph, draw a line from $PNR = 237$ to the number of teeth scale, $N = 14$ (standard), which will intersect the non-graduated line of the nomograph. From this intersection, draw a line to the pitch scale, $P = 1^1/_4$ (diametral), which will intersect the tooth load scale, and the tooth load (under S_B = 22 kips per sq in.) is recorded. From this intersection, draw a line to $PNR = 237$, on the extreme right scale of the nomograph, which will intersect the horsepower scale. At this intersection (under S_B = 22 kips per sq in.), the horsepower rating of the gear is read.

Thus the horsepower is 2.69 < 2.84 required, W = 4.5 kips, but using a 4-in. face (1.5 circular pitch < 4 in. < 3.0 circular pitch), the horsepower is 4 × 2.69 = 10.76 > 10.7 required (O.K.).

Second Solution: The face width is obtained for normal load and then increased 50% to allow for 150% overload. Try pinion

$$\left.\begin{array}{l} P = 1^3/_8 \text{ diametral pitch} \approx 2.28 \text{ in. circular pitch} \\ R \approx 6.75 \\ N = 14 \end{array}\right\} PNR = 215$$

$f = 1.5$ circular pitch $= 1.5 \times 2.28$ in. $= 3.42$ in. min.

The horsepower equals $7.5 \times 95\% = 7.13$, and for a 1-in. face it equals $\frac{7.13}{3.42} \approx 2.09$. From the chart the horsepower equals $2.2 > 2.09$ (O.K.). $W = 4.1$ kips per sq in. Final pinion face $= 3.42 \times 150\% = 5.13$ in. Adopt $f = 5$ in. Horsepower of pinion $= 5 \times 2.2 = 11.0 > 7.13 \times 150\% \approx 10.7$ (O.K.). 1.5 circular pitch $= 3.42$ in. < 5 in. face < 3.0 circular pitch $= 6.84$ in. (O.K.).

In the first solution the pitch diameter is $\frac{NP}{\pi} = \frac{14 \times 2.51 \text{ in.}}{3.14} \approx 11.19$ in.

In the second solution the pitch diameter is $\frac{14 \times 2.28 \text{ in.}}{3.14} \approx 10.16$ in.

The final adoption of the pinion will depend on whether the allowable maximum bore is equal to or greater than the required diameter of the shaft. If the bore is insufficient for the shaft, a pinion with more teeth will have to be tried.

Shear and Bond Stresses in Wedge-Shaped Reinforced Concrete Beams

By ROBERT B. B. MOORMAN

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF MISSOURI, COLUMBIA, MO.

WITH the more extensive use in recent years of reinforced concrete beams of variable depth, it might be of interest to restate the derivation for the unit shearing stress in wedge-shaped beams.

Let Fig. 1 represent a portion of a wedge-shaped beam with the stresses and dimensions shown thereon.

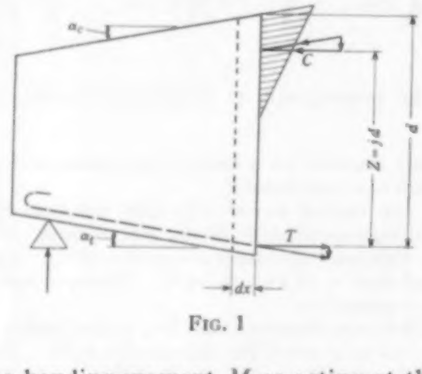


FIG. 1

Consider a bending moment M as acting at the section. Let T be the horizontal component of the stress in the steel. Then by taking moments about the resultant of the compressive stresses we have

$$M = ZT \text{ or } T = \frac{M}{Z} \qquad \text{(1)}$$

Differentiating Eq. 1, we have

$$dT = \frac{ZdM - MdZ}{Z^2} \qquad \text{(2)}$$

Dividing both sides of Eq. 2 by the differential dx gives

$$\frac{dT}{dx} = \frac{dM}{dx}\frac{1}{Z} - \frac{M}{Z^2}\frac{dZ}{dx} \qquad \text{(3)}$$

Now the rate of change of the bending moment, dM/dx, at any section is the shear, V, at that section. Also, by definition $Z = jd$. Then upon substituting these expressions in Eq. 3 we have

$$\frac{dT}{dx} = \frac{V}{jd} - \frac{M}{(jd)^2} j \frac{d}{dx}(d) \qquad \text{(4)}$$

But $\frac{d}{dx}(d) = \tan \alpha_c + \tan \alpha_t$, and $dT = vbdx$ or $\frac{dT}{dx} = vb$, where v is the unit horizontal shearing stress and b is the width of the beam.

Equation 4 may then be rewritten

$$vb = \frac{V}{jd} - \frac{M}{jd^2}(\tan \alpha_c + \tan \alpha_t) \qquad \text{(5)}$$

and

$$\left.\begin{array}{ll} & v = \dfrac{V}{bjd} - \dfrac{M}{bjd^2}(\tan \alpha_c + \tan \alpha_t) \\ \text{or} & v = \dfrac{1}{bjd}\left[V - \dfrac{M}{d}(\tan \alpha_c + \tan \alpha_t)\right] \end{array}\right\} \qquad \text{(6)}$$

Equation 6 is the desired expression for the unit shearing stress in a wedge-shaped reinforced concrete beam.

In order to derive the expression for unit bond stress, let us consider the change in stress in the steel in the distance dx. The horizontal component of this change in stress is dT. The change in the stress in the direction of the reinforcement is $\frac{dT}{\cos \alpha_t}$ and the length of the bars is $\frac{dx}{\cos \alpha_t}$. If Σo is the perimeter of all the bars at any section and u is the average unit bond stress, then we have

$$\frac{dT}{\cos \alpha_t} = \frac{\Sigma o u dx}{\cos \alpha_t} \qquad \text{(7)}$$

or

$$u = \frac{dT}{dx}\frac{1}{\Sigma o} \qquad \text{(8)}$$

Noting that $\frac{dT}{dx} = vb$ and substituting Eq. 5 in Eq. 8, we have

$$u = \frac{1}{\Sigma ojd}\left[V - \frac{M}{d}(\tan \alpha_c + \tan \alpha_t)\right] \qquad \text{(9)}$$

which defines the unit bond stress.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Stress Analysis of Three-Ring Brick Sewers

To the Editor: Mr. Sawyer's article on "Simplified Stress Analysis of Three-Ring Sewers," in the November issue, offers useful equations for designing structures of this type. Considering that the equations may be used for design purposes, it is advisable that some form of a check be made. A more rigorous theoretical analysis may be based on two equations given in Vol. II of *Modern Frame Structures* (by Johnson, Bryan, and Turneaure) for the moment and thrust at the crown of a hingeless arch. Dropping the moment of inertia, I, which is constant, and changing to polar coordinates shortens the process of integration. Then $ds = Rd\theta$, $x = R\sin\theta$, and $y = R(1 - \cos\theta)$.

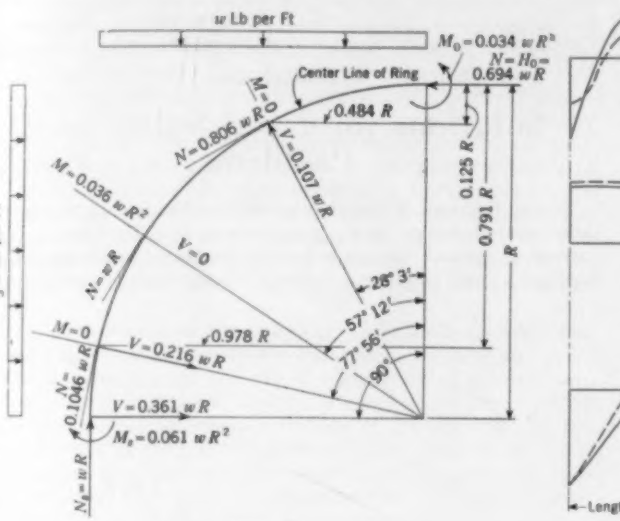


Fig. 1

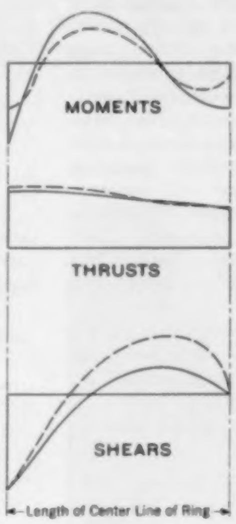


Fig. 2

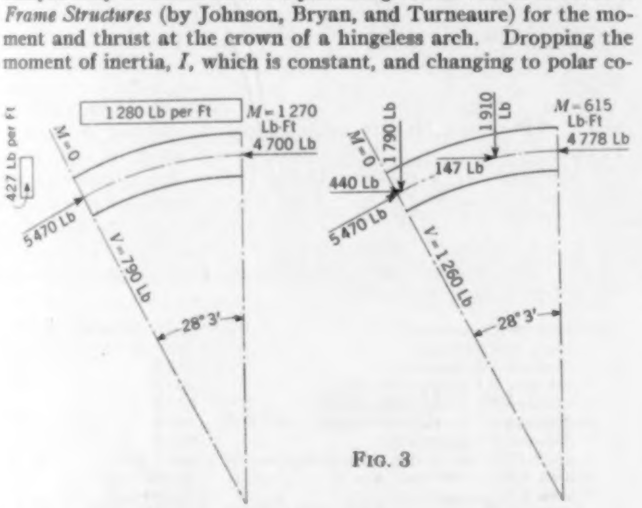


Fig. 3

If we adopt a uniform vertical load on the span of the arch, the transformed equations will become

$$H_0 = \frac{1}{R}\,\frac{\int d\theta \int M'(1-\cos\theta)d\theta - \int M'd\theta \int (1-\cos\theta)d\theta}{[\int (1-\cos\theta)d\theta]^2 - \int d\theta \int (1-\cos\theta)^2 d\theta}$$

$$M_0 = \frac{\int M'd\theta \int (1-\cos\theta)^2 d\theta - \int M'(1-\cos\theta)d\theta \int (1-\cos\theta)d\theta}{[\int (1-\cos\theta)d\theta]^2 - \int d\theta \int (1-\cos\theta)^2 d\theta}$$

If these two equations are integrated between the limits zero and $\pi/2$, the equations reduce to $H_0 = 0.560wR$, and $M_0 = 0.045wR^2$.

For a uniform horizontal load, equal to one-third of the vertical load and extending over the rise of the arch on both sides, acting toward the arch center, the transformed equations will become: $H_0 = 0.134wR$, and $M_0 = -0.011wR^2$. Adding the above results, the final equations are $H_0 = 0.694wR$, and $M_0 = 0.034wR^2$ (tension at inside face of ring).

With these results, it is possible to obtain the maximum moments, thrusts, and shears. At the spring line the thrust $N_s = wR$; the moment $M_s = 0.061wR^2$ (tension at inside face of ring); and the shear $V_s = 0.361wR$.

When the shear is zero, the direction of the thrust is tangent to the curve of the arch. The value of the central angle for this point is derived from a right triangle, the vertical leg of which is equal to $wR\sin\theta$ and the horizontal leg equals $0.694wR - {}^1/_3wR\,(1 - \cos\theta)$. The resulting angle $\theta = 57°\,12'$, and the thrust $N = wR$.

An equation is formed by taking moments of all forces to the right of any section through the arch rib of the left half, in terms of polar coordinates. If the equation is differentiated with respect to (θ) and the results equated to zero, two angles will be found where the moments equal zero. They are $28°\,3'$ and $77°\,56'$.

By using the crown as an axis for moments of all forces to the right of the above points, the shears are found to be $0.107wR$ and $0.216wR$, respectively.

The accompanying Fig. 1 shows the results of the above computations. For the purpose of comparing the results with those obtained by Mr. Sawyer an arch of 10 ft inside diameter and an earth cover equal to 10 ft at the crown has been selected. The vertical load is equal to the product of the unit weight of earth by the area bounded between two vertical lines drawn from the ends of the spring lines of extrados up to the ground surface, the line of the intrados, and the ground surface.

The dotted lines in Fig. 2 are plotted results from Mr. Sawyer's equations, and the full lines are those of the writer. The values of the moments and shears at and near the crown differ by large sums. This can be explained by applying loads of both methods to a section of arch between crown and point of zero moment, and computing crown moments and left-end shears. Figure 3 carries out this method and indicates that the results of both methods shown by Fig. 2 are substantially correct. The divergence of the results is caused by replacing the uniform load with concentrated loads too widely separated.

Needham, Mass. Scott W. Orr, Assoc. M. Am. Soc. C.E.

Ground-Water Supplies in the Mid-Continent Area

To the Editor: I have noted with interest George S. Knapp's paper, "Water Resources of the Mid-Continent Area," in the October issue. The problem of supplying water to industries, municipalities, agriculture, and other uses in this region is one that is receiving increasing attention, and the recent occurrence of droughts has greatly emphasized this problem.

In the article it is indicated that surface water reservoirs are subject to large amounts of evaporation and that evaporation from water surfaces in pans during the past 15 years has increased as much as 10 in. annually. In areas of low precipitation and extremely low runoff, such as the mid-continent area, the question of evaporation losses from surface reservoirs becomes one of the controlling factors in selecting the type of water-supply source.

The decline of ground-water levels in this area during the past decade has forced many localities to investigate all possible sources

of water supply to replace or augment their existing ground-water supplies. In many instances, surface waters are not available and, if available, are not sufficient to satisfy the needs of the communities, which are now faced with the problem of going farther afield for their water.

Attention should be called to the possibility of making use of present ground-water reservoirs by increasing the infiltration of surface water in the area serving as an intake into these ground reservoirs. In 1935 L. K. Wenzel, in U.S. Geological Survey Water Supply Paper No. 772, stated that ground-water levels in the Platte River valley in central Nebraska are affected by the infiltration of surface irrigation waters. Mr. Wenzel reported that in 1935 the ground-water level in the vicinity of Lexington, Nebr., was from 10 to 15 ft above the level in 1896, doubtless resulting from seepage of irrigation water. In California it is common practice to spread surface runoff water over land areas, the water seeping through to recharge the ground-water storage.

Inasmuch as it is recognized that infiltration and seepage from irrigation waters may increase the available ground-water supplies, why not also recognize the possibility of increasing such supplies generally throughout a large region by certain land-use practices on agricultural areas. As stated in Nebraska Agricultural Experiment Station Research Bulletin 112, tests on small areas have shown that the presence of crop residues (mulch) and the operation of certain land-use practices increase to some extent the intake of water into the ground. Land-use practices that will conserve moisture for agriculture may, in some cases, be used to conserve moisture that will find its way into ground-water storage.

The Hydrologic Division of the Soil Conservation Service has established an experimental watershed in the mid-continent area near Hastings, Nebr., to study the effect of land use on the conservation of soil and moisture and on floods. Although the ground-water table in the vicinity of this watershed is too deep to be materially affected by the intake of water over the ground surface, the data on rates of water intake of the soil under different treatment should be very useful to water-supply consulting engineers in the region described by Mr. Knapp's paper.

LLOYD L. HARROLD, Assoc. M. Am. Soc. C.E.
Associate Hydraulic Engineer, U.S. Soil Conservation Service
Washington, D.C.

Designing Bridges for Unusual Trailer and Truck Loadings

DEAR SIR: In his paper on "Developments in Western Bridge Engineering," in the December number, Mr. Housecroft points out the possibility of large overstresses in bridges due to unusual trailer and truck loadings.

Sufficient consideration has not been given to this possibility in most highway bridge specifications. On four-lane bridges, the problem is important only in connection with the design of stringers. But on two-lane bridges it may influence the design of floor beams, and on short spans it may, to some extent, influence the design of girders. Mr. Housecroft calls attention to one of the important elements in the problem—the ratio of live to dead load in the structure.

A few years ago the Allegheny County Authority, in preparing specifications for a large bridge program, included clauses requiring investigation of the structures for an 80-ton trailer load in conjunction with normal vehicular and street car traffic loading. For this combination, an increase in unit stress of 50% above normal was permitted. All the bridges in this program were designed to provide for four lanes of traffic and two sidewalks. As a result, the trailer loading influenced only the design of roadway stringers, and the additional cost of the structure was relatively small. In this specification, however, the normal vehicular loading used for short spans was somewhat larger than that provided by the H-20 loading of the American Association of State Highway Officials' specification. The specification of the Allegheny County Authority also provided for the investigation of all members for a live load 50% in excess of normal with a maximum increase of 25% in unit stresses.

By these clauses, a design was obtained giving a reasonably constant factor of safety for any condition of emergency overloading. As Mr. Housecroft points out, the present H-loading specifications do not accomplish this purpose. This is particularly true for members receiving maximum stress from short loaded lengths and for members in which the ratio of live to dead load is high.

Engineers responsible for the maintenance of old highway bridges generally find the safe load limit controlled by the capacity of members receiving their maximum stress from short loaded lengths. Present specifications, to a large extent, perpetuate this weakness in highway bridge design. With relatively moderate additional initial expenditures, our bridges could be made adequate to carry any unusual heavy trailer or truck loads without serious overstress.

It is possible that the use of some of our highways for national defense purposes may give further importance to this problem at this time. Bridges designed for H-15 or H-20 loading may be adequate to carry most military equipment, but it seems probable that the full use of our highways for such purposes will require, at least occasionally, the transport of equipment with very heavy axle concentrations.

G. S. RICHARDSON, M. Am. Soc. C.E.
Consulting Engineer
Pittsburgh, Pa.

Solutions for Land Subdivision Problems

TO THE EDITOR: With reference to Mr. Kinslow's article on land subdivision problems, in the August issue, and the subsequent discussion, it appears that the solutions illustrated in the accompanying Figs. 1 and 2 have the advantage of easy visualization with relative simplicity. It will also be noted that they may be extended to cases where AB is not a straight line.

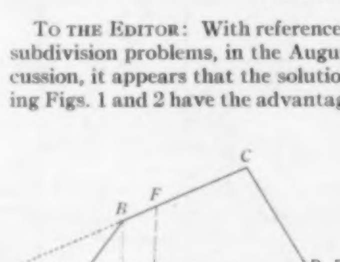


FIG. 1

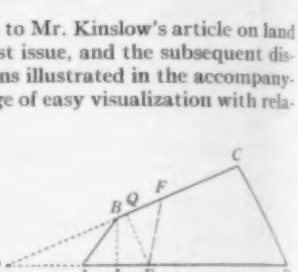


FIG. 2.

In the first case, where $BJEF$ is a trapezoid, the resolution into triangles makes less difference in simplicity, but because of the general familiarity with the relationships of triangles the addition of an area to produce a triangle appears to be a useful general approach.

In Fig. 1 Angle $DEF = 90°$, and the distance AE is unknown; in Fig. 2 the Angle DEF is unknown and the distance AE known. In both figures, $P = A + B - 180°$; $h = d \sin A$; $m = h/\tan P$; $f = m - d \cos A$; $q = fh/2$. In Fig. 1, $P = A + B - 180°$; $h = d \sin A$; $m = h/\tan P$; $f = m - d \cos A$; $q = fh/2$; $s = mh/2$; $S = q + T$; $M^2/m^2 = S/s$; $M = (m^2S/s)^{0.5}$; $x = M - f$. In Fig. 2, $M = f + x$; $v = (M \sin P)(M \cos P)/2$; $w = T + q - v$; and $y = 2w/M \sin P$. The symbols have the following general significance and the assumed numerical values:

A = angle BAD (known)	$\tan^{-1} 0.8 = 53° 07' 57''$
B = angle ABC (known)	$149° 29' 14''$
d = distance AB (known)	250 ft
f = distance PA (computed, step 4)	330 ft
h = distance BJ (computed, step 2)	200 ft
m = distance PJ (computed, step 3)	480 ft
M = distance PE (computed)	600 ft
P = angle CPD (computed, step 1)	$\tan^{-1} 5/12 = 22° 37' 11''$
q = area ABP (computed, step 5)	33,000 sq ft
s = area BJP (computed)	48,000 sq ft
S = area EFP (computed)	75,000 sq ft
T = area $ABFE$ (known)	42,000 sq ft
v = area EPQ (computed)	63,905 + sq ft
w = area EFQ (computed)	11,095 − sq ft
x = distance AE (known in second case; required in first case)	270 ft
y = distance FQ (required in second case)	96.16 − ft

The foregoing numerical values were chosen for simplicity in checking the calculations, but the equations are perfectly general. If v is greater than S, the value of y will be negative.

In both figures P is the intersection of AD and BC continued, and BJ is perpendicular to AD. In Fig. 1 EF is perpendicular to AD by hypothesis; in Fig. 2 EQ is drawn perpendicular to BC.

Portland, Ore. HOWARD B. STANLEY, Assoc. M. Am. Soc. C.E.

Private vs. Government Enterprise

Dear Sir: It is highly desirable from several standpoints to know the history of engineering and of engineer pioneers, and for that reason articles depicting the various phases of the profession are always welcome. Therefore Prof. W. E. Howland's paper, "The Concept of Engineering—Development of the Eighteenth Century," in the November issue, would be especially appreciated if it were not for certain notes which, it seems to me, indict the whole economic system of free enterprise rather than inveigh against the evils of a few or the mistakes of early development.

These notes are the unnecessary emphasis on government schools, the implication that free enterprise is synonymous with unrestricted greed, and the inference that all the benefits of science and engineering are grabbed by the few and that nothing goes to the benefit of the many under such an economic system.

Professor Howland shows that industrial progress began as a private enterprise. Presumably the benefits of that progress could have been obtained whether private or government enterprise had prevailed, but because of the lack of motive in the latter case, the question remains—would these benefits have been obtained?

Benefits of scientific progress will come to others in three forms—new jobs or reduced costs of needed goods, or new goods to satisfy new and old needs. The full benefits can be obtained by the common people only when put into products that they can use at a price which they can afford to pay—that is, at a price within reach of their earning power. They can be made available only when someone with foresight and understanding undertakes the risk and responsibilities of providing the product. Certainly, if the "laborer is worthy of his hire," the entrepreneur deserves a fair profit.

In the early stages of the industrial revolution, factories and working conditions were undoubtedly crude. Nothing else could have been logically expected, for it takes time to develop non-material as well as material things; the revolution of the better social order is slow, not so much because of the repression by the few but because of the mental inertia of society as a whole. It is probable that working conditions were no worse under the new order in that day than under the preceding one. It has taken over 100 years to accomplish the little improvement of putting the burden of risk of accident on the industry instead of the employee.

It should always be remembered that any government or agency created by government is still run by men. A government has no superior intellect above that of the best individuals available to assume government duties. It has no form of magic by which the benefits of science or engineering can be obtained without work or without some form of commerce. It has no means for the production of wealth, or the creation of wants, or the production of goods to satisfy the old or the new needs except those available to private individuals. It has power only to enforce commands, good or bad, and may block progress as readily as advance it; and if its personnel is admittedly "sitting on top of the world," it may be counted on to block rather than to aid progress.

Finally, in comparing the benefits of science through private or government action, one should not overlook the research laboratories now operated by the larger private industrial corporations, or the universities that exist by private endowment from wealthy individuals.

Edgar E. Foster, Assoc. M. Am. Soc. C.E.
Associate Engineer, U.S. Engineer Office
Omaha, Nebr.

Preserving Leather Book Bindings

To the Editor: Along the lines of previous items in Civil Engineering on preserving leather book bindings, a formula for a dressing given in the *British Museum Quarterly* (Vol. 2, No. 3, December 1927) may be of interest. This calls for 7 oz (avoirdupois) of anhydrous lanolin, $1/2$ oz (avoirdupois) of beeswax, 1 oz (fluid) of cedarwood oil, and 11 oz (fluid) of hexane.

Dissolve the beeswax in the hexane, being careful to keep away from any flame that might ignite the hexane. Then add cedarwood oil, and last the lanolin, which previously should have been softened by warming. Shake the mixture well before using. This is a good mixture for vellums as well as leathers. Before using the dressing the leather should be washed as usual, and dried for several days in a warm room. Then the dressing should be rubbed in well, and after 48 hours the surface may be polished.

For the preservation of old vellum and paper, use a 2% solution of celluloid in equal volumes of amyl acetate and acetone. Give the sheet several coatings with a soft brush, and allow each coat to dry before applying the next one.

Edwin S. Fickes, M. Am. Soc. C.E.
Annapolis Royal, Nova Scotia

Geography at Grand Coulee

To the Editor: The cover of the December number of Civil Engineering shows one of the best pictures of the Grand Coulee Project that I have yet seen. It is so good that space might well have been given in that issue to a description.

For instance, in the right foreground is the contractor's town, which already shows the effect of water in combination with soil, as indicated by the growth of trees. In the center foreground are the contractor's camp and shops, with the aggregate conveyor belt terminating in the stock piles of graded sand and gravel. A conveyor belt extends from the stock pile to the twin concrete-mixing plants.

The engineers' town is reached by crossing the river by the cantilever bridge in the foreground. The trees growing there

Unusual Variety of Detail in Aerial View of Reclamation Project
Cover Photo from December Civil Engineering

again indicate the effect of water in this otherwise arid region. Immediately upstream from the dam is what appears to be an island, but is actually a collection of logs, trees, and trash conveyed by the river from lands upstream as they became submerged by the rising waters of the lake. It is interesting to note that this trash was alive with rattlesnakes seeking refuge from the rising water. During the summer of 1940 before the lake level was lowered temporarily the trash was towed to shallows (which later became exposed) and destroyed by fire.

At the power plant building at the shore end there may be discerned a separate building which is about seven stories high. This is for office and warehouse purposes and gives a slight idea of the proportions of the project.

Scattered in the middle background are the various towns and subdivisions laid out by private concerns, and in the center background at the top of the picture are the dim outlines of Steamboat Rock, which will become an island in the balancing reservoir to be formed by upper and lower dams in the Grand Coulee. The grayish color on either side of Steamboat Rock is surface water in the bed of the Grand Coulee.

P Hetherton, Assoc. M. Am. Soc. C.E.
Executive Officer, Washington State Planning Council
Olympia, Wash

Analysis of Rainfall Records

DEAR SIR: In an article by Hugh F. Kennison, in the November issue, entitled "Sixty-Year Rainfall Record Analyzed," it is stated that "a longer record tends to reduce the magnitude of the intensities of precipitation for each frequency curve, and this effect increases with the rarity of recurrence of the storm." This statement is undoubtedly true in the record used in the article and will be true in many other cases. However, it should not be understood to apply universally. The effect of a longer record will, in any case, depend on the relative intensities of precipitation occurring in the supplementary period as compared with those occurring in the original period. A supplementary period of high intensities would increase the magnitude of intensities for the frequency curves.

In the accompanying table rainfall intensities at Louisville, Ky., from a 40-year record are compared with those from a 24-year record. The intensities are from data of the automatic recording rain gage of the U.S. Weather Bureau. The intensities shown in the table are based on the "extended duration principle," as used by Mr. Kennison. However, the values for Louisville are from actual rainfall rates rather than from smooth curves based on the actual rates.

It will be observed in the table that the longer record reduces the magnitude of the intensities for some durations but increases the intensities for other durations, while some are unchanged. The total change, considering all durations, is less for the more frequent storms (2-year frequency), but the changes are more uniform in direction for the rarer storms. The maximum change for any duration is only 8.9%, which is not a large variation for rainfall data.

Computations for intermediate frequencies, such as 4-, 8-, and 16-year frequencies, give results similar to those shown in the table—that is, the intensities based on the 40-year record are in some cases greater than, in some cases less than, and in some cases equal to those based on the 24-year record. Computations based on 32 years of record, intermediate between the periods shown in the table, also give results similar to those shown for 24 and 40 years of record.

RAINFALL INTENSITIES AT LOUISVILLE, KY., FROM A 40-YEAR RECORD COMPARED WITH THOSE FROM A 24-YEAR RECORD

Duration in Minutes	2-Year Frequency: Intensity, In. per Hr., From 24-Year Record	2-Year Frequency: Intensity, In. per Hr., From 40-Year Record	2-Year Frequency: Change %	24-Year Frequency: Intensity, In. per Hr., From 24-Year Record	24-Year Frequency: Intensity, In. per Hr., From 40-Year Record	24-Year Frequency: Change %
5	4.44	4.56	+2.7	9.24	9.00	−2.6
10	3.54	3.48	−1.7	6.90	6.86	−0.6
15	3.00	2.96	−1.3	5.60	5.41	−3.4
20	2.58	2.58	0.0	4.77	4.47	−6.3
25	2.38	2.37	−0.4	4.03	3.73	−7.4
30	2.08	2.08	0.0	3.44	3.43	−0.3
45	1.65	1.65	0.0	2.43	2.42	−0.4
60	1.26	1.33	+5.6	2.00	1.95	−2.5
80	1.05	1.12	+6.7	1.82	1.80	−1.1
100	0.89	0.90	+1.1	1.62	1.51	−6.8
120	0.79	0.77	−2.5	1.36	1.27	−6.6
180	0.57	0.55	−3.5	1.00	1.00	0.0
240	0.45	0.41	−8.9	0.79	0.82	+3.8
300	0.36	0.36	0.0	0.64	0.67	+4.7
360	0.30	0.30	0.0	0.54	0.57	+5.6

In 1921 the Commissioners of Sewerage of Louisville adopted a 15-year rainfall curve for design of combined sewers and drains, based on the 24-year record referred to. In 1929 this curve was studied in the light of the 32 years of record then available, and it was stated (in a "Report of Commissioners of Sewerage of Louisville," dated October 16, 1929) that "this curve . . . is still applicable and that no change is required." This statement is more or less in line with the data presented herein.

C. FRANK JOHNSON, Assoc. M. Am. Soc. C.E.
Senior Engineer, Commissioners of Sewerage of Louisville

Louisville, Ky.

The Stepping Method of Stadia

TO THE EDITOR: In "Shortcut to Indirect Leveling" in the December issue, Mr. Alsup is describing a method similar to the stepping method of stadia. In practice the stepping method of stadia is used as follows: To "turn up" one space or set the line of sight on a +1% grade, level the telescope and see where the top stadia hair intersects some well-defined object. With the slow-motion screw, turn the telescope up until the bottom stadia hair is in the position formerly occupied by the top stadia hair. Additional spaces can be turned up by a continuation of the method. Spaces may be turned down by reversing the procedure. After the rod reading r (the reading where the horizontal cross hair intersects the rod) has been taken, the telescope may be re-set to facilitate reading the stadia intercept or distance. It will be convenient to record the stadia notes according to the following tabulation:

H. I. = 978.40

Dist.	H. Angle	+ or −	r	R	Elev.
75	274° 15′	0	7.5		970.9
160	268° 45′	0	9.3		969.1
480	109°	+1	3.1	+1.7	980.1
115	178° 20′	+4	0.6	+4.0	982.4
200	65°	−4	10.7	−18.7	959.7
370	47° 30′	+1/2	1.6	+0.3	978.7

The stepping method of stadia is hardly as accurate as stadia methods using vertical arc readings. But it is rapid, eliminates the use of stadia reduction tables, and is sufficiently accurate for most practical purposes.

E. L. HARRINGTON, Assoc. M. Am. Soc. C.E.
Instructor in Civil Engineering, Agricultural and Mechanical College of Texas

College Station, Tex.

Field Tests for Foundation Design

DEAR SIR: "Practical Shear Tests for Foundation Design" by Trent R. Dames, in the December issue, offers much interesting material for the foundation engineer. The use of field tests in conjunction with laboratory studies and the resulting correlations are of special value.

In Fig. 7 (*a*) Mr. Dames shows a graph of settlement against load for a field-bearing test. The question arises as to the rate of application of load. If the loads were added very rapidly, so as to eliminate the effect of consolidation on the soil, then the yield point determined by the test would have a definite relation to the shearing strength of the soil. However, if the loads were applied at a slow rate, the settlement curve would show both the effects of consolidation and plastic yield. In the latter case, the "yield point" and resulting correlations would be meaningless.

In discussing correlations between field-bearing tests and laboratory shear tests, Mr. Dames has cited a theoretical value of 3.14 as the proper ratio between the load at yield point and the shearing strength of the soil. This ratio, given by Nadai, is for plane stress in an elastic material. It is valid only for the case of a footing that is extremely long for its width. Presuming that the bearing plate used in the tests was round or square, the ratio would have to be determined for three-dimensional stress distribution. In this case, the ratio would no longer be a fixed constant, but would vary with different values of Poisson's ratio. For a Poisson's ratio of 0.3, the ratio of yield load to maximum shearing stress is 3.03. If Poisson's ratio is increased to 0.5, the value becomes 3.47. Variations in the Poisson's ratio for the material tested may therefore account for the "spread" observed in different types of soil.

In view of the fact that soil in general is neither elastic, isotropic, nor homogeneous, one is hardly justified in attempting to carry out the correlation ratio to two decimal places, anyway. Why not call the ratio 3 and forget the fraction?

E. W. VAUGHAN, Jun. Am. Soc. C.E.
Chief Soil Technician, The Panama Canal

Balboa, C.Z.

Error Corrected

[*Editor's Note:* Attention of readers is called to the letter entitled "Extraction of Square Root Simplified," on page 660 of the October issue, in which a typographical error appears. The second sentence reads: "Setting $y = x$, and taking the the differential we have $dy = \dfrac{dx}{2\sqrt{x}}$." The first equation should, of course, read $y = \sqrt{x}$.]

SOCIETY AFFAIRS

Official and Semi-Official

Frederick Hall Fowler—Society President for 1941

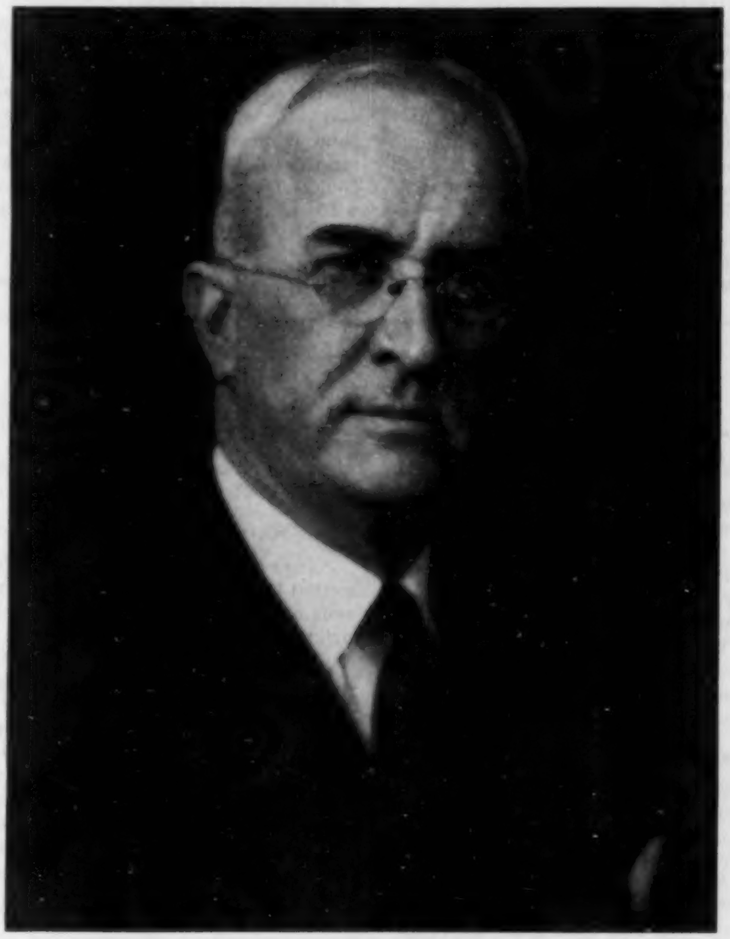
Even a casual acquaintance would remark the military bearing of Frederick H. Fowler—his dignity of carriage, his forthrightness of expression and action. The source of these traits is not hard to discover; many he inherited and the remainder he probably imbibed from his boyhood surroundings.

His was a romantic youth, or so at least most boys would consider it. He was born in an Army camp—in Fort Custer, Mont. This was Indian country and the fort took its name from that celebrated fighter, General Custer. In fact, Custer's tragic death had occurred only three years previous to Fowler's birth. That indicates how close he was in time and place to the wild West in its heyday.

Similar scenes and influences came to bear upon his youth. His father was an Army officer, and it so happened that his early life was spent largely in Army posts in the West. His common schooling completed, he entered upon a period of comparatively settled life when he enrolled at Stanford University. At the outset, his college activities were largely literary. He first majored in English and became immersed in college dramatics and similar campus interests. Later—and very fortunately, his friends believe—he switched his attention to engineering.

In this new channel of college activity his clarity of thought, his receptive and logical mind, promptly made him outstanding. Certainly, the combination of academic and engineering studies has been a most fortunate one in his case. He exemplifies the success that should attend the proper fusion of cultural and scientific pursuits. In this, fate (or good judgment) put him several decades ahead of his day. He had the breadth of training that modern educators have been demanding for engineers. To judge by the results, such a curriculum certainly must have many advantages.

His degree from Stanford University was Bachelor of Arts in Civil Engineering. Apparently there was no conflict of interests, no uncertainty in Mr. Fowler's mind, for he immediately plunged into civil engineering work and has been active in it ever since, mainly in the coast states. First he was on construction, in charge of work on the California section of the Laguna Dam across the Colorado near Yuma, Ariz. There followed a short period of survey work on a proposed water supply for San Francisco. Then came a year teaching civil engineering at his alma mater and another on surveys in Michigan. For twelve years following 1910 he was in the U.S. Forest Service at San Francisco, where he rose to the position of District Engineer. In connection with this work he served for two years as engineering representative for the Federal Power Commission in California and Nevada.



Frederick Hall Fowler
President of the American Society of Civil Engineers

With this background he established, in 1922, a consulting office in San Francisco and has maintained it ever since. Particularly outstanding have been his services for the various branches of the government, such as for the Corps of Engineers on dam design for California rivers, for the Federal Emergency Administration of Public Works, for the flood protection of greater Kansas City, for the National Park Service, and for the Los Angeles Department of Water and Power. More recently he has been special consultant to the Public Works Administration on the Fort Peck, Grand Coulee, and Bonneville dams. He was on the Board of Review of the Florida Ship Canal and the Passamaquoddy Project, and was chairman of the latter board. He was in charge, as director, of the National Drainage Basin Study covering the entire United States.

During his busy professional life, Mr. Fowler has otherwise contributed to the welfare of the profession. Two papers by him and a number of discussions have been printed by the Society. He also shared in the monumental report on earthquakes, as a member of the Society's Special Committee on Effect of Earthquakes. Other committee assignments included those on Flood Protection Data and Masonry Dams.

He has always interested himself in local engineering activities; he served on the Governor's committee to investigate causes leading to the failure of the St. Francis Dam. And during 1939 he was president of the San Francisco Section of the Society, as no one who attended the San Francisco Convention that year will soon forget. Other organizations that have profited by his active interest include the Seismological Society of America, the Society of American Military Engineers, and the American Ornithologists Union. He has been president of the Stanford Alumni Association. Aside from his active interest in all Society matters, he served for one term as a member of the Board of Direction, from 1928–1930. He thus brings to his new office a broad outlook on engineering and Society problems, developed over a long period.

Reference has been made to Mr. Fowler's striking physical bearing, so characteristic of the army man. This was probably accentuated by his service during the World War as Captain of the 211th Engineers. Those who have known him intimately for many years say that even from college days he exhibited those high mental and moral attributes which mark the exceptional man.

One of his notable characteristics has always been his keen sense of humor, the ability to recall graphically and to relate entertainingly many amusing incidents. These may have reference to his social contacts or they may point a moral to some professional incident. But always he uses them to clarify and illustrate the thoughts or engineering conclusions that he wishes to convey.

Strange as it may seem for an engineer, Mr. Fowler's hobbies are travel, literary activities, and historical study. Soon after the completion of his college work, he spent a year traveling in Europe and in Egypt. His interest in literature, in languages, in biography and travel, has continued keen and has been further stimulated by the foreign excursions he has found time for in the course of the years. His keen observation and retentive mind have enabled him to acquire from these experiences a wide background of knowledge both geographical and historical. His associates love to induce him to make observations on his travels

Another of Mr. Fowler's hobbies is observing the habits of birds. He is an experienced and enthusiastic falconer, and his holidays in California have been largely spent in indulging this fancy. As opportunity offered, probably on a Sunday, he and one of his sons would be found suspended by ropes over some cliff in the Coast Range, armed with a moving picture camera and making a graphic record of the private life of a family of falcons whose nest they had located. Time after time he would return to the same nest so as to film the whole life history, including the growth and development of each individual member, of that particular bird family.

For some time he maintained a sort of refuge for falcons near his home. Mornings and evenings he spent training them, observing their characteristics and habits and making a written record. He is the author of several authoritative articles on bird life. One of these, illustrated with his own photographs, was prominently featured in the *National Geographic Magazine* a few years ago.

In public, and especially on the rostrum, he appears to advantage. He has an easy manner, a conversational but exact mode of expression, and a delightful humor that wins his hearers. This talent should stand him in good stead during his coming term of office.

His gracious wife, who has made the Fowler home noted for its hospitality, has accompanied her husband on numerous trips. The daughter of Dr. J. C. Branner, famous geologist and president of Stanford University, Mrs. Fowler has lived both before and since her marriage in Palo Alto. Two sons have completed their work at the University and are now on their own.

Aside from his zeal in engineering work, his hobbies and recreations, and his ability to transmit his observations effectively and agreeably to those about him, Mr. Fowler's chief characteristics have been his high standard of personal integrity, his broad-minded and judicial attitude, his independence of thought, and his thoroughness in everything he undertakes. It goes without saying that he has been popular among his fellow engineers; no one could have borne the manifold responsibilities that have been his without the confidence of his associates. His many friends feel justified in expecting great things from his presidential term. They predict for him an outstanding record as the presiding officer of the Society during a most important year of its history.

The Society in 1940

As Shown by Some Excerpts from the Annual Report of the Board of Direction

The Eighty-Eighth Year

This Eighty-Eighth Year, 1940, seems to have been notable in several respects. The membership is the largest ever. An active part has been taken in the National Defense Program. A representative has been stationed in Washington. Practical classifications of services and related pay have been worked out for the engineers in the highway departments of two states. A Committee on Civilian Protection in War Time has been appointed, and has established relations with the Federal Government. A rather larger than usual series of publications has been issued. The Society withdrew from American Engineering Council.

Membership

In 1931 Juniors constituted 18.7% of the total membership. At present the percentage is 26.4. Total membership is now the greatest in the history of the Society—16,662, a net increase of 662 during this calendar year.

National Defense

The most unusual events of the past year have arisen in connection with national defense. The Society's participation in the defense program consisted of four major elements: the commissioning of President Hogan, as chairman, with four other members of the Society, as the Construction Advisory Committee to the Army and Navy Munitions Board; the development of the National Committee on Construction Preparedness, with Secretary Seabury as chairman; the placing of Field Secretary Jessup at Washington to look after the interests of civil engineers; and the appointment of a Committee on Civilian Protection in War Time. Direct expenditures carried on the books of the Society under the caption National Defense Program, total $2,354.73.

Construction Advisory Committee

Most of their work must be considered confidential, but it may be summarized as dealing with general policies, varying from the forms of contracts to be entered into for engineering, architectural, and construction services, to the relative time periods requisite for the design and construction of the various types of defense facilities as influenced by local situations, including estimates of the volume and quality of skilled labor available. Most recently, the assistance of this committee has been sought in obtaining the services of qualified technical personnel to aid Zone Construction Quartermasters in each of the nine zones recently established for defense construction.

National Committee on Construction Preparedness

At the request of the Army and Navy Munitions Board, transmitted by the Construction Advisory Committee, a census of persons available for engagement on the construction necessary for defense projects was conducted.

Of the questionnaire returns, 2,709 were taken to Washington and made available to the Quartermaster Corps, the Civil Engineer Corps of the Navy, and the Corps of Engineers of the Army. The names and addresses of those individuals listed as available for supervision of construction were sent daily, for a period, to the Quartermaster General of the Army, and the lists of those individuals available for assimilation into expanding engineering or contracting organizations were retained in 55 local state or city depositories. In this work the Society received the collaboration of nine other national engineering societies.

Society Representative at Washington

At its July meeting, the Board of Direction decided that a member of the staff should spend as much time as was necessary in Washington, during the development of the National Defense Program, to look out in all practical ways for the interests of civil engineers. In accordance with this action, Field Secretary Jessup took up temporary residence in Washington late in July, and has maintained contact there on several matters continuously since that date.

With the very generously afforded help of many members, when called upon, he has aided in the preparation of contract forms for professional services, and in the determination of costs and fees to be paid to engineers or engineering firms to be retained on defense work by the Government in the Construction Division of the Quartermaster Corps, the Bureau of Yards and Docks of the Navy, the Corps of Engineers of the Army, the Federal Works Agency, and the U.S. Housing Authority.

Committee on Civilian Protection in War Time

A Committee on Civilian Protection in War Time, authorized by the Board of Direction, has been appointed to study those features and operations which should be instituted for the protection of life, health, and property in communities which may be subject

to enemy attack. The several members of the committee, each a specialist in his line, will act together as a coordinating committee, surrounded by such other members of the Society, or specialists in other but related technical lines, as are in a position to work out specific problems as they arise. Also, they will direct and coordinate the local activities of the Local Section committees to be appointed.

Salary Surveys

At the request of the appropriate Local Sections, and under the consulting supervision of former members of the Board of Direction, complete classification and salary surveys of the engineering staffs of two state highway departments were made, in Arizona and in Nevada.

Personnel Service

The Engineering Societies Personnel Service, Inc., has offices in New York, N.Y., Chicago, Ill., Detroit, Mich., and San Francisco, Calif.

The number of men placed during 1940 has averaged about 104 per month. The following table shows the registrations and the placements in the four offices:

Month	Men Registered					Men Placed				
	New York	Chicago	Detroit*	San Francisco	Total	New York	Chicago	Detroit*	San Francisco	Total
January	213	68	..	95	376	51	30	..	22	103
February	204	83	..	65	352	45	19	..	17	81
March	222	80	..	97	399	50	17	..	24	91
April	210	89	..	100	399	51	14	..	22	87
May	193	98	..	119	410	43	17	..	22	82
June	218	143	..	93	454	40	16	..	21	77
July	221	109	45	89	464	54	16	2	19	91
August	185	65	78	69	397	60	29	3	33	125
September	193	67	61	50	371	57	35	8	21	121
October	159	68	54	70	351	74	31	12	32	149
November	136	30	39	51	256	57	30	6	25	118
December	154	29	52	58	293	51	33	11	27	122
Total	2,308	929	329	956	4,522	633	287	42	285	1,247

* Service inaugurated July 1, 1940.

Summary of Publications for 1940

Publication	Issues	Average Edition	Total Pages	Cuts
Proceedings (monthly numbers)	10	16,940	2,024	479
Civil Engineering (monthly numbers)	12	17,100	1,214	924
Transactions, Volume 105	1	16,130	2,080	463
Manuals Nos. 18, 19, and 20	3	17,560	264	24
Yearbook	1	17,080	592	7
	27	......	6,174	1,897

Engineering Societies Library

The statistics which follow give comparative figures for 1939 and 1940 of the Engineering Societies Library:

	1938–1939 (Oct. 1–Sept. 30)		1939–1940 (Oct. 1–Sept. 30)	
Additions:				
Volumes—by gift	1,659		1,642	
by purchase	1,207	2,866	1,180	2,822
Maps—by gift	158		80	
by purchase	19	177	16	96
Searches		49		33
Total additions		3,092		2,951
Permanent collection		146,999		149,734
Expenditures for books, periodicals, binding, supplies, and salaries (approximate)		$46,836		$45,612
The library was used by		43,110		40,576
Including personal visits by		32,471		30,181
Volumes catalogued		2,935		2,843
Cards added to catalog		12,479		10,952
Total catalog cards		470,442		479,159
Searches made		84		64
Translations made		113		119
Photoprints made		21,907		21,679
Number of persons securing photographs		2,508		2,478
Receipts for service		$ 8,512		$ 8,912
Members borrowing books		162		221

Reading Room of the Society

The registered attendance at the Reading Room during the year was 2,222.

Two hundred and sixty-seven periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and daily newspapers.

Finances

It has been the custom of the Board of Direction for several years past to expand the Society's activities as extensively as possible by drafting and revising the budget so as to appropriate for approved activities as nearly as practicable the total income that reasonably could be expected. Fortunately, the Society's accumulated surplus is invested largely in the "57th Street Property" and in other real estate, income from which has not decreased proportionately with the income generally available from securities. This income from investments has enabled the Society to render service in amount considerably greater than would have been practicable if dues constituted the sole source of revenue.

Due to the unusual net increase in membership and to an unusually small number of members in arrears this year, the excess of income over expenditures is somewhat greater than usual; about 4.5% of income.

Local Sections

There are at present 64 Local Sections, the Tri-City Section approved by the Board of Direction on January 16, 1940, having been added during the year. The name of the Kansas State Section was changed to Kansas Section.

Membership of Technical Divisions

City Planning	710
Construction	3,419
Engineering Economics	880
Highways	1,552
Hydraulics	2,145
Irrigation	586
Power	741
Sanitary Engineering	1,325
Soil Mechanics and Foundations	1,721
Structural	2,893
Surveying and Mapping	1,071
Waterways	750
Total	17,793

Student Chapters

During the year three new Student Chapters were chartered, three were disbanded, and one changed its name, leaving the total at 120. The new Chapters are at Colorado State College, Northeastern University (Boston), and Southern Methodist University (Dallas). The Chapters at Antioch College and at Pennsylvania Military College were disbanded, while the Chapter at Lewis Institute gave up its charter to merge with the Armour Institute Chapter. These two Chapters in turn changed their name to Illinois Institute of Technology Chapter, following the merger of the two institutions.

Of General Interest

Certain government agencies in the defense program have adopted a ruling that all drawings submitted for approval must bear the stamp and seal of a professional engineer. Some contract drawings recently received by the Fourth Naval District at Philadelphia, instead of showing the seal of a professional engineer, carried the stamp of a draftsman's union. The drawings were rejected.

* * * *

Current interest in all matters connected with aviation has prompted the Engineering Societies Library to prepare a list of references on the Design and Construction of Airplane Hangars. The list includes one hundred articles selected from those published during the years 1928–1940 in the leading domestic and foreign periodicals, and contains material on both steel and reinforced concrete structures. Copies may be obtained by sending $2 to the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

Civil Defense Keynotes Eighty-Eighth Annual Meeting

But Tenor of Sessions, Dinners, and Business of Seeing People Reflects Little Change

THE Eighty-Eighth Annual Meeting opened on January 16 with a faint suggestion of important differences from other years. Except for the deliberate emphasis given the civilian protection program by the "questions and answers" to which the general meeting was devoted, there was nothing visible in the session schedules to indicate the deep undercurrent of preoccupation with the vital defense movement. Some names were missing from the register, and such phrases as "gone to Puerto Rico," "to Trinidad," or "to Newfoundland" were frequently overheard. However, a registration of over 1,600 was recorded.

On the first morning, the reading of the Board of Direction's, Secretary's, and Treasurer's reports was followed by the award of medals, prizes, and honorary memberships. These awards are the symbols by means of which the Society attests the importance of excellence in creative technical work. It is therefore gratifying that nearly all the recipients were able to be present.

Announced more fully in the January issue, the honors and their winners merit a brief recapitulation:

Norman Medal	Shortridge Hardesty Harold E. Wessman
J. James R. Croes Medal	Edward J. Rutter Quinton B. Graves Franklin F. Snyder
Thomas Fitch Rowland Prize	John D. Galloway
James Laurie Prize	A. M. Rawn A. Perry Banta Richard Pomeroy
Collingwood Prize for Juniors	Kenneth D. Nichols
Rudolph Hering Medal	J. W. Ellms
Construction Engineering Prize	Russell G. Cone
Daniel W. Mead Prize	Allen Jones, Jr.
Honorary Members	Charles P. Berkey George H. Fenkell J. D. Galloway F. G. Jonah Reginald H. Thomson

Climax of the morning was the presentation of the John Fritz Medal, awarded to Ralph Budd for the most distinguished service in any of the major branches of engineering. The honor was conferred by William Henry Harrison, past-president of the American Institute of Electrical Engineers and chairman of the John Fritz Medal Board.

Luncheon, served on the fifth floor of the Engineering Societies Building, was welcomed both because of its completely adequate fulfillment of the normal purpose of a luncheon and because the arrangements were so well adapted to the renewal and extension of acquaintances. There was complete informality and room to move about.

The discussion of bomb and sabotage defense measures in the afternoon was led by E. P. Goodrich, vice-chairman of the Committee on Civilian Protection. Brief explanations of the committee functions were followed by a cross-fire of questions, answers, and arguments relating to aspects of the subject as widely divergent as the control of water supply against the introduction of germ cultures, and coordination of the committee's work on emergency reconstruction with the training of local fire departments.

The Student Conference, held concurrently with the general meeting, was addressed by Colonel Hogan in a vein similar to that developed in the larger assembly. At this session the Daniel W. Mead Prize was awarded to Harry A. Balmer for the best student paper on professional ethics.

The remainder of the meeting carried no direct reference to defense problems. The smoker on Wednesday evening provided another opportunity for members to find each other for the continuance of discussions begun earlier. Skilled performers beguiled the intellectual haze with song and dance, and subsequent refreshments beguiled the parched throats and starved interiors with appropriate appeal.

Thursday's sessions were devoted to technical contributions sponsored by the Power, Sanitary Engineering, Structural, City Planning, Highway, and Waterway Divisions. The session on Applied Mechanics had to be adjourned to larger quarters, and even these proved insufficient to accommodate those interested.

Papers were presented as planned, with few exceptions. Lively interest was manifested through discussion from the floor. It is fortunate that engineers carry only professional weapons.

ENTERTAINMENT AND EXCURSIONS

The luncheon and fashion parade attended by the ladies were so generally acclaimed that husbands will have cause to regret the popularity of the occasion, that is, if the expected effect on the family budget materializes. The cuisine was much appreciated and (we are advised) the arrangements for the presentation of apparel styles were carried out with finesse.

On Thursday night the dinner and dance at the Waldorf-Astoria were thoroughly enjoyed. A large number of engineers and ladies, an atmosphere of good fellowship, a splendid meal, the reception for the new President and Honorary Members, and of course dancing to fine music—all these contributed to the enjoyment of the festivities. This event was the social climax of the meeting.

On Friday morning Prof. F. B. Farquharson accompanied his moving pictures of the Tacoma Narrows Bridge collapse with a clear

Photo by Acme

JOHN FRITZ MEDAL PRESENTED TO RALPH BUDD (CENTER)

At Left, William Henry Harrison, Past-President American Institute of Electrical Engineers; at Right, Henry E. Riggs, Past-President of the American Society of Civil Engineers

and "human" account of the circumstances, and their probable significance. For this popular event, the large auditorium was almost full; in fact late comers had to crowd the doors and aisles. The rest of the day—a cold, wet, slushy one—was devoted to an inspection of La Guardia Field and, on the way, the newly opened Queens-Midtown Tunnel, the Triborough Bridge (with a view of the Wards Island Sewage Treatment Plant), and the new East Side Drive.

Incidental and unofficial adjuncts to the meeting were the college reunions, dinners, and meetings of various sorts. As usual, plans for the whole meeting were carefully prepared and carried out without a hitch. From the moment a member entered the flower-decorated foyer where registration was under way, tickets furnished, and other help offered, until he finally left at the conclusion of the program, he found his wants anticipated. This is to say that the committee in charge did a most excellent job. Memories of serious discussion on national matters, of friendly chatter with old and new friends, of meaty presentation of technical ideas, and of delightful social events will be the souvenirs of the Society's Eighty-Eighth Annual Meeting.

A Proposed Undergraduate Civil Engineering Curriculum

Specific Suggestions Invited

By SAMUEL B. MORRIS

CHAIRMAN, 1940, OF THE COMMITTEE ON ENGINEERING EDUCATION

THE "REPORT of the Committee on Aims and Scope of Engineering Curricula," published by the Society for the Promotion of Engineering Education in its *Journal* for March 1940, suggests broadening the base of engineering education. It proposes that parallel development of the "scientific-technological" and the "humanistic-social" stems should be emphasized to carry the engineering student more deeply into the social sciences and humanities as well as into the physical sciences in order to stimulate a rounded educational growth which will continue into professional life.

Among engineering educators there is general acceptance of this pronouncement. However, there is no close agreement as to just what is meant by the broad statement of "scientific-technological" and "humanistic-social" fields in terms of actual courses. Probably it is fortunate that there is not too clear an agreement, as the content of engineering curricula should not be frozen. There should be ample opportunity to fit the curricula to the best faculty and facilities available, and also to the general character of the students and to the demands made on graduates.

In order to elicit some discussion I am submitting herewith a curriculum, complying with the recommendations of the S.P.E.E. committee. The amount of time for each subject or group of subjects has been expressed in percentage of the total time for the full four years of undergraduate training, as the value of semester units or quarter units varies widely among engineering schools. This suggested curriculum may be roughly divided into approximately one-fourth each in humanistic-social, physical sciences, engineering fundamentals, and civil engineering applications. It is only fair to state that the members of the Society's Committee on Engineering Education have not agreed that this is the ideal curriculum. It is submitted by the 1940 chairman of that committee as a specific, somewhat detailed interpretation of the S.P.E.E. committee recommendations, in the hope that it will arouse specific comments. However, I do not wish wholly to disclaim support for this curriculum, as it agrees substantially with that given for a number of years at the institution with which I am connected.

It should be noted that the structural engineering stem of civil engineering is the only one emphasized in this curriculum. In my opinion, this is the basic stem in which some proficiency should be obtained by all students. Other specialties such as hydraulic and sanitary engineering may be optional beyond the minimum time shown in this curriculum.

Again may I emphasize that there is no single best curriculum for all engineering schools. A proven ideal curriculum at one institution may differ widely from a proven excellent curriculum at another institution. Neither school could adopt the curriculum of the other without distinct loss, as it would probably not fit either faculty or students.

FOUR-YEAR CURRICULUM IN CIVIL ENGINEERING

SUBJECT MATTER AND GROUP	PERCENTAGE OF TIME
Scientific-Technological	
Chemistry	5–7%
Mathematics	10–14
Physics	7–9
Geology	3–4
Engineering drawing and descriptive geometry	3–4
Surveying, including highway and railway location	7–10
Physical metallurgy and processing	4–5
Engineering mechanics, including statics, dynamics, mechanics of materials, hydraulics, soil mechanics, and properties of materials	12–14
Thermo-dynamics and heat-power	3–4
Elements of electrical machinery, including a-c and d-c machinery and circuits	3–4
Structural engineering, including stress analysis, elements of design, reinforced concrete, and foundations	10–12
Water supply and sewerage	4–9
Transportation engineering, including highways and railroads	2–6
Engineering economy, valuation, specifications, and contracts	4–6
Humanistic-Social	
English, composition, scientific report writing, and public speaking	8–12
Language and literature	3–5
Social sciences, selected from history, economic theory, psychology, philosophy, business law, and accounting	9–12

For Full and Open Discussion

THE SOCIETY has always stressed the importance of its technical papers and their discussion. Discussion receives the more generous space allowance in PROCEEDINGS, although in CIVIL ENGINEERING also, as much space is devoted to that purpose as is consistent with the informal character of that publication.

The aim in PROCEEDINGS is in effect to make the first printing an invitation for comment—"something to shoot at." The idea underlying this policy is that free debate should be permitted to bring out the strength or weakness of the author's original position. All of us realize that, try as we may, we cannot always avoid biased views in our writing, or even errors of omission and oversight. Enthusiasm, although it is the tonic required to put vitality into any work, may lead us into unconscious understatement or overstatement. Knowing our own failings as authors, as readers we welcome the comments of contemporary engineers on matters of importance to future work. In any event, the engineering world can feel much more confidence in a proposition that has run the gauntlet of informed criticism.

The virtue of TRANSACTIONS is of course the correlation which that publication gives to the entire body of argument on a particular subject. Judging from the premium placed on this final volume in the minds of many engineering readers, the duplication is worth the cost.

In the present publications scheme, discussion is clearly the backbone of the more technical literature. And for subjects that deserve the maximum detailed consideration, PROCEEDINGS and TRANSACTIONS are the appropriate organs.

In and About the Society

THE CENTRAL Illinois Section has passed a resolution approving the proposed "Illinois Professional Engineering Act" designed to require qualification of engineers before permitting them to practice in that state.

* * * *

MISUSE of the designation "Engineer" has been checked by the Metropolitan Local Section's Committee on Professional Relations. Upon complaint by the committee to the State Education Department, a firm that displayed the title "Realty Engineers" agreed to change the sign in an early repainting.

Papers Filed in the Library

BY AUTHORITY of the Committee on Publications, the following papers have been designated for filing in the Engineering Societies Library, 29 West 39th Street, New York, N.Y., where they may be readily consulted. Quotations for photostating will gladly be made by the Library.

DISTRIBUTION OF FOOTING PRESSURE

FREDERICK C. LOWY, Assoc. M. Am. Soc. C.E., "Analytical Terms for Distribution and Maximum Intensity of Pressure Under

Rectangular Footings" (17 typewritten, double-spaced pages, of which five are diagrams). Formulas and charts are given for computing the intensities and distribution (planar) of normal stresses over a rectangular area when the position of the resultant normal force is known. The analysis may be considered as applying to the cross section of a plain concrete pier (unable to resist tensile stresses) possibly more than to foundations.

Deflections by Three-Moment Method

OHNO, ISAMU. (Japan), "The Three-Moment Method" (8 pages handwritten text, including 12 small diagrams). A method is developed for computing the deflection of prismatic beams with the help of the three-moment equation. A number of illustrations are computed in detail.

Solving Simultaneous Equations

WEINER, BERNARD L., M. Am. Soc. C.E., "An Exact Method for the Solution of Simultaneous Equations by Variation of Coefficients" (17 pages of text, single-spaced, plus 11 pages of extensive numerical tabulations). This ingenious method for solving a series of linear simultaneous equations is theoretically rigorous and leads to correct arithmetical solution. The method falls into partial solutions, each complete in itself and therefore adaptable to continuous checking. It is said to require less work than ordinary methods and to be susceptible of slide-rule computation.

Fort Peck Slide

KITTRELL, CLARK, M. Am. Soc. C.E., "The Fort Peck Slide—Explorations and Reconstruction" (39 typewritten, double-spaced pages, plus five maps and charts, two photographs). Brief description is given of the foundation, methods of construction, phenomena of the slide, and subsequent investigations. The major part of the paper consists of official reports of the Board of Consultants, including a 13-page minority report by the late Thaddeus Merriman, M. Am. Soc. C.E.

Highway Economics

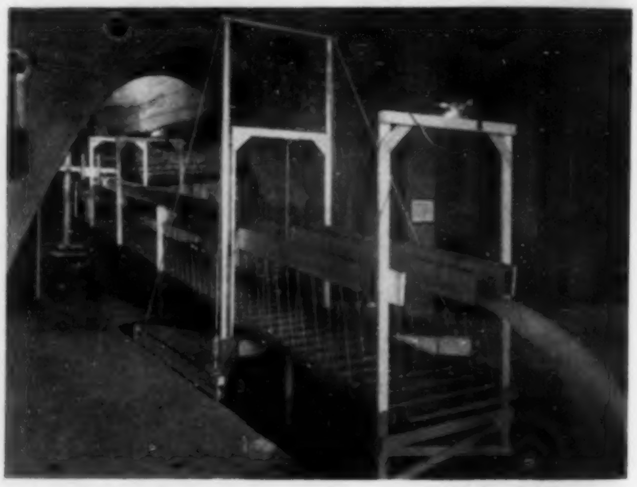
ROBLEY, WINFREY, Assoc. M. Am. Soc. C.E., "Investment Return as a Cost Factor in Highway Operation" (20 typewritten pages double-spaced). Investment return—that is, interest on investment—is discussed as applied to determining the total cost to the public of furnishing highway service. It is shown that this return is a true cost of operation, but the public may not wish to charge the beneficiaries of highway service for it, since even without it the system could remain solvent.

Suspension Bridge Design by Influence Lines

ASPLUND, CAPT. S. O. (Sweden), "Application of Influence Lines to the Deflection Theory of Suspension Bridges" (double-spaced manuscript includes 17 pages mathematical text, 7 pages design computations, 5 pages tables, 10 charts, and appendix of 19 tables, of which 5 are extensive). An expeditious method is presented, using formulas, tables, and charts, for designing suspension bridges with two-hinged stiffening trusses and unloaded backstays, according to the deflection theory. After reducing calculation to the case of a unit bridge of unit length and unit dead load, remaining factors of design are found, including cable property constants, flexibility factor of truss, and live load. It is said to be the first scientific solution involving application of influence lines to accurate analysis of suspension bridges.

Status of Surveying

FROST, LLOYD G., Assoc. M. Am. Soc. C.E., "Surveying in the United States" (42 pages text double-spaced, 1 map, 6 office forms). Questionnaires were submitted to state officials and engineering educators in forty-six states. The results show the status of surveying throughout the country, the extent to which state plane coordinate systems have been adopted, and a wide expression of opinion relative to such adoption. These data are discussed in the light of experience in Louisiana.



Practical But Basic Results Sought by Hydraulic Committee

In its Seventh Annual Report, the Society's Committee on Hydraulic Research describes progress on eight continuing and three new fields of investigation in addition to letter symbols, the hydraulic laboratory manual, and a study of field data on conformity between models and prototypes. *Conversion of Kinetic to Potential Energy in Expanding Conduits* and *Traveling Waves on Steep Slopes* are projects in the report-writing stage. Closed conduit junctions were studied and reported on in connection with the project, *Phenomena of Intersecting Streams*. A final paper on *Curves in Open Channels* should be ready in 1941. *Sedimentation at the Confluence of Rivers* is being studied with the aid of motion pictures and the special flume, upper left. White lines are bed contours. *Air Resistance to Flow of Water in Open Channels* is a subject with which many chute, spillway, and stilling-pool problems are concerned. Bubbles, left, were "stopped" at a velocity of 40 ft per sec with an exposure of $^1/_{1,000,000}$ sec. The flume, upper right, is designed for slope adjustment while in operation. *Simultaneous Flow of Liquids and Gases* is a project utilizing transparent pipes. *Field Studies of Air Entrainment in Chutes and Spillways* continue to yield such unusual results as the discovery that at Grand Coulee the water coming out of the tunnel carried three times its volume of air. *Critical Depth Weirs*, *Nature of Hydraulic Friction*, and *Supercritical Flow in Open Channel Transitions* are the new projects. J. C. Stevens is chairman of the committee, and Chilton A. Wright, secretary.

Mead Prize Competition for 1941

Topics for the 1941 Daniel W. Mead Student Prize and Junior Prize papers on ethics were announced by the Board of Direction at the Annual Meeting. "Ethics of the Engineer Inspector" and "Ethics of Junior Construction Engineers" are the subjects for students and Juniors, respectively.

Rules for these prizes, which may be obtained in reprint form upon application to the Secretary, provide that the topics shall be selected each year by the Committee on Professional Conduct, which also selects the prize winners. The committee consulted the donor of the prizes, Past-President Daniel W. Mead, before deciding on the topics.

The awards for the year ending July 1940 were announced in the November 1940 issue of Civil Engineering, and the presentations were made at the Annual Meeting last month. Lt. Allen Jones, Jr., Jun. Am. Soc. C.E., now on duty with the Army, received his prize during the Wednesday morning session, and Harry A. Balmer, of the George Washington Student Chapter, received his at the Student Chapter Conference in the afternoon.

Entries for 1941 in each competition must be made before July 1. Many good ideas on these subjects need expression. Try it.

Society's Defense Committee Is Affiliated with War Department

Secretary Stimson Appoints Walter D. Binger Chairman of Seven-Man National Committee for Civilian Protection

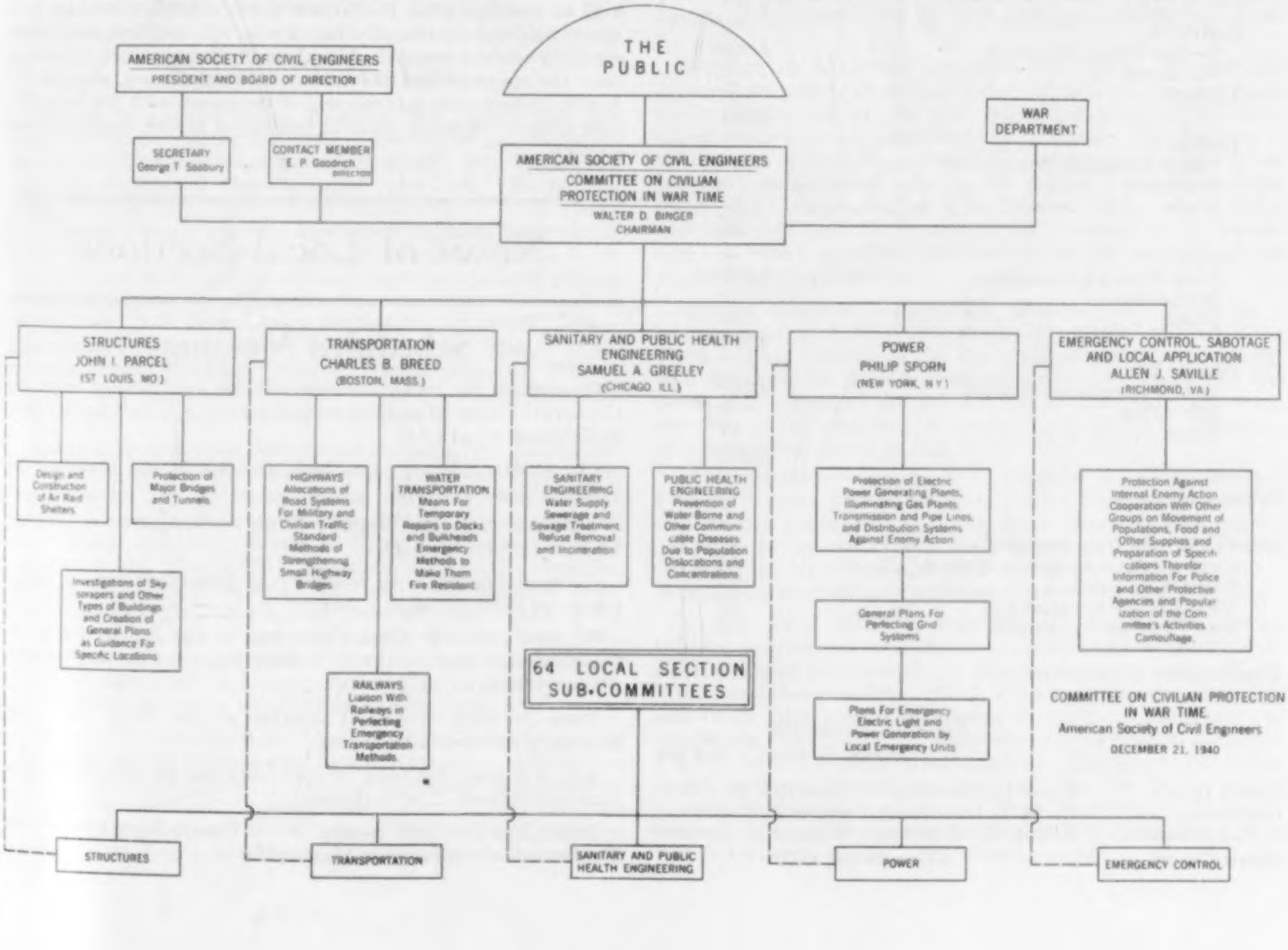
The action announced by Secretary of War Henry L. Stimson on January 13 formally incorporates the Society's Committee on Civilian Protection in War as a part of a national committee on the same subject with the Society's chairman, Walter D. Binger, as chairman of the national group. In his letter to Mr. Seabury, Secretary Stimson wrote, "your letter in which you propose that a committee of engineers on a national scope be organized to supply such technical information on the engineering basis of civil defense as the War Department may require of it, be appointed by the Secretary of War, has received careful attention. . . . I feel that such a committee will be of great value to the War Department in matters which concern the protection of the civil population from air and other attack."

In addition to Mr. Binger the national committee will include W. H. Carrier, of Syracuse, N.Y., representing the American Society of Heating and Ventilating Engineers, Harry E. Jordan, New York City, of the American Water Works Association, A. B. Ray, New York City, representing the American Society of Chemical Engineers, Abel Wolman, Baltimore, Md., representing the American Public Health Association, James L. Walsh, New York City, representing the American Society of Mechanical Engineers, and Scott Turner, of New York City, representing the American Institute of Mining and Metallurgical Engineers.

The Society's original committee, as announced in the January issue of Civil Engineering, was appointed as a result of action taken at last summer's convention of the American Society of Civil Engineers at Denver, when Col. John P. Hogan, retiring President of the Society, appointed Walter D. Binger, Manhattan Commissioner of Borough Works, who accepted on condition that no further appointments would be made until a close contact had been made with the War Department, after which he would select a committee whose personnel would embrace the type of man and mind best suited for civilian protection in war.

The organization and functions of the Society's committee are illustrated in the accompanying chart. At the opening session of the Annual Meeting in New York, the committee conducted a panel and round-table discussion to consider "measures for providing ample protection of life and property against attack." Also protection against loss of life by air raid, protection of water supplies and other utilities against damage from sabotage or air bombing, and provision for prompt repair were considered.

On orders from Secretary Stimson, the War Department held a meeting in October attended by staff representatives of various sections and an Assistant Secretary of War. At this meeting working arrangements were made to cooperate informally with the Society's Committee. According to the announcement by the Secretary of War, the new national committee will "assist the War Department in technical matters relating to the collection, evaluation, and dissemination of information of value in the protection of civilians and vital civilian installations in time of war."



Final Ballot on Society Officers for 1941

January 8, 1941

To the Eighty-Eighth Annual Meeting
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1941 report as follows:

For President:		
Frederick Hall Fowler	4,095	
Scattering	4	
Blank	5	
	4,104	
For Vice-Presidents		
Zone II:		
Charles Henry Stevens	4,066	
Scattering	3	
Blank	35	
	4,104	
Zone III:		
Charles Baker Burdick	4,066	
Scattering	3	
Blank	35	
	4,104	
For Directors		
District 3:		
John Whitfield Cowper	4,062	
Scattering	3	
Blank	39	
	4,104	
District 5:		
Gustav Jaeger Requardt	4,066	
Scattering	2	
Blank	36	
	4,104	
District 7:		
William Nelson Carey	4,062	
Scattering	2	
Blank	40	
	4,104	
District 8:		
George Bragg Massey	4,065	
Scattering	1	
Blank	38	
	4,104	
District 9:		
Ralph Benjamin Wiley	4,067	
Scattering	0	
Blank	37	
	4,104	
District 12:		
John Wilbur Cunningham	4,064	
Scattering	2	
Blank	38	
	4,104	
District 16:		
Ernest Emmanuel Howard	4,063	
Scattering	0	
Blank	41	
	4,104	
Ballots canvassed		4,104
Ballots withheld from canvass:		
From members in arrears of dues	13	
Without signature	89	
With illegible signatures	23	
Void—improperly marked	6	
Total withheld		131
Total number of ballots received		4,235

Respectfully submitted,
E. WARREN BOWDEN, *Chairman*

Joseph Farhi	Frank L. Greenfield	Frederick W. Ockert
Ivan Rosov	Harry T. Immerman	Frank V. Hayes
C. P. Melioransky	Edward N. Whitney	Malcolm S. Spelman
Harris Grand	*Committee of Tellers*	

Maryland Section Stimulates Junior Activities

By E. M. KILLOUGH, ASSOC. M. AM. SOC. C.E.
VICE-PRESIDENT, MARYLAND SECTION

The following abstract from the proceedings of the Local Sections Conference held in Cincinnati on October 15, 1940, at the time of the Fall Meeting of the Society, is presented with the thought that it may be of value to other Sections in their relationship with their Juniors.

REALIZING that the future of the Society depends to a large extent on its younger members, the Maryland Section takes an active interest in its Juniors. The present policy is to appoint a Junior on each of the regular committees of the Section, thus encouraging their interest in the Section and keeping them informed of its various activities. The officers believe that if an interest in their Local Section is instilled in Juniors, a larger percentage of them will become corporate members when they are old enough to qualify.

At all regular meetings of the Section, the Juniors are encouraged to express their views and participate in the discussions. These arrangements have resulted in splendid cooperation between the Section and its Junior Forum. The attendance of Juniors at meetings has increased since they started to serve on our regular committees. The Junior members of these committees, of course, keep the Forum informed of the work being done by the Maryland Section. Of the 42 Juniors listed in the Yearbook as being in the Baltimore zone, 25 are identified with and active in the Junior Forum. The average attendance at the monthly meetings of the Junior Forum is 22. The officers of the Maryland Section felt that young engineers should have an opportunity to discuss the problems of the profession with each other, and that they needed to meet the older and more experienced men in the profession. They arranged therefore with the Engineers' Club of Baltimore for the Juniors to use the club's facilities one evening a month. The club makes no charge for these meetings, which are held on a night when the other club members are engaged in chess tournaments. Individual Juniors alternate in bearing the slight expense of the refreshments served at the conclusion of the meeting.

These meetings, which are conducted entirely by the Juniors, are held on evenings when the Section is not meeting. It is the custom to hold eight or nine meetings a year. In addition, the Juniors regularly conduct one of the Maryland Section meetings, furnishing both the speakers and the topic. It is customary, also, for the Juniors to hold their last meeting of the season with the local Student Chapter, at which time the benefits of joining the Society are stressed.

News of Local Sections

Scheduled Meetings

CINCINNATI SECTION—Evening meeting held jointly with the Cincinnati Technical and Scientific Societies in Wilson Auditorium on February 19, at 8 p.m.

CLEVELAND SECTION—Luncheon meeting at the Guildhall on February 3, at 12:15 p.m.

COLORADO SECTION—Dinner meeting at the University Club on February 10, at 6:30 p.m.

GEORGIA SECTION—An assembly at Georgia School of Technology on February 10, at 7:30 p.m.

ILLINOIS SECTION—Dinner meetings of the Junior Section at the Central Y.M.C.A. (19 S. LaSalle St.) on February 10 and February 24, at 6 p.m.

IOWA SECTION—Technical meeting at the Hotel Fort Des Moines on February 10, at 8 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on February 12, at 6:15 p.m.

MARYLAND SECTION—Smoker of the Junior Association at the Engineers Club on February 14, at 8:15 p.m.

Metropolitan Section—Technical meeting in the Engineering Societies Building on February 19, at 8 p.m.

Miami Section—Dinner meeting at the Alcazar Hotel on February 6, at 7 p.m.

Nashville Section—Dinner meeting in Kissam Hall, Vanderbilt University, on February 3, at 6:30 p.m.

Northeastern Section—Dinner meeting of the Junior Association at the Graduate House, M.I.T., on February 12, at 6:30 p.m.

Northwestern Section—Dinner meeting of the Junior Chapter at the University of Minnesota Union, on February 17, at 6:30 p.m.

Philadelphia Section—Social meeting at the Engineers Club in Philadelphia on February 22, at 6 p.m.

Pittsburgh Section—Symposium on Engineering Education at the William Penn Hotel on February 19, at 8 p.m.

Sacramento Section—Regular luncheons at the Elks Club every Tuesday at 12:10 p.m.

St. Louis Section—Luncheon meeting at the York Hotel on February 24, at 12:15 p.m.

San Francisco Section—Regular bi-monthly dinner meeting at the Engineers Club of San Francisco on February 18, at 5:30 p.m.

Spokane Section—Luncheon meeting at the Davenport Hotel on February 7, at 12 m. (Regular luncheon meetings are held at the Davenport Hotel on the second Friday of each month.)

Tacoma Section—Dinner meeting at the Lakewood Community Center on February 11, at 6:30 p.m.

Tennessee Valley Section—Dinner meeting of the Chattanooga Sub-Section at the Y.W.C.A. on February 11, at 6:30 p.m.

Texas Section—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on February 3, at 12:10 p.m.

Tri-City Section—Dinner meeting on February 14, at 6:30 p.m.

Wisconsin Section—Dinner meeting at the City Club, Milwaukee, on February 13, at 6:30 p.m.

Wyoming Section—Dinner meeting at Casper, Wyo., on February 27, at 6:30 p.m.

Recent Activities

Arizona Section—*Phoenix, November 23:* Papers were presented by Dean G. M. Butler, of the University of Arizona, whose subject was "Trends in Engineering Education"; James B. Girand, consulting engineer of Phoenix, whose paper dealt with the proposed Colorado River Aqueduct for central Arizona; C. C. Huskison, resident engineer for the Arizona State Highway Department, whose topic was "Earthquake Damage in the Imperial and Yuma Valleys"; and S. F. Turner, who discussed the status of groundwater investigations in Arizona. The papers were discussed by W. W. Lane, D. C. Scott, Henry Frauenfelder, and R. V. Leeson. The annual election of officers held at this time resulted in the selection of the following: Julian W. Powers, president; John H. Gardiner, first vice-president; John A. Carollo, second vice-president; and W. T. Wishart, secretary-treasurer.

Buffalo Section—*November 29 and December 17:* The speaker at the first of these luncheon meetings was Charles R. Velzy, works superintendent for the Buffalo Sewer Authority, who gave an illustrated lecture on the need for the Buffalo disposal plant and its method of operation. A talk on "Civic Demands on Business and Professional Men in 1941" was the feature of the December meeting. This was given by Leston Faneuf, vice-president of the Marine Midland Group, Inc., and chairman of the Public Relations Committee of the New York State Bankers Association. During the business meeting the following officers were elected for 1941: Wallace Carr, president; William Huber, vice-president; Charles Velzy, secretary; and Norman Herthe, treasurer.

Central Illinois Section—*Champaign, December 3:* During this session it was unanimously decided to send a resolution to Governor-elect Dwight H. Green recommending that qualified engineers be appointed to those state offices charged with the direction of engineering work. Then W. W. De Berard, Director of the Society, presented a certificate of life membership to Prof. E. E. King. The technical program consisted of a symposium on water supply. Those participating were H. A. Spafford, H. L. White, W. M. Lansford, and F. C. Amsbary, Jr. At the conclusion of this program the following officers were elected for 1941: R. P. Hoelscher, president; W. H. Wiseley, first vice-president; P. Z. Michener, second vice-president; and H. P. Evans, Jr., secretary-treasurer.

Central Ohio Section—*Columbus, December 11:* Joint dinner meeting with the Ohio State University Student Chapter. Following the presentation of a certificate of life membership to Philip Burgess, group singing, with Don Johnstone at the piano, was enjoyed. Later the gathering was entertained by Reeder Hutchinson, who presented a magician's performance, and W. W. Bartlett of Otterbein College, who gave "human interest sketches." Former president Robert N. Waid installed the officers for 1941 (announced in the January issue) and stated that the treasurer-elect, Tahlman Krumm, would not be able to serve because he is in military service.

Cincinnati Section—*December 10:* Joint dinner meeting with the Student Chapter at the University of Cincinnati. A symposium on engineering education was the feature of the occasion, the speakers being H. D. Loring, vice-president of the Ferro Concrete Construction Company; H. B. Luther, head of the department of civil engineering at the University of Cincinnati; and T. J. Smull, of Ohio Northern University. A certificate of life membership was presented to Frederick B. Duis.

Colorado Section—*Denver, December 9:* On this occasion, which was the annual Ladies' Night, certificates of life membership were presented to A. O. Ridgway and O. T. Reedy. Clarence Rawhouser then gave a brief analysis of the Section membership, and several committee reports were presented. It was announced that the new officers for 1941 are R. L. Parshall, president; R. N. Tracy, vice-president; and Harry L. Potts, secretary-treasurer. Dancing concluded the evening.

Dayton Section—*December 16:* The annual election of officers, held at this luncheon meeting, resulted as follows: J. F. Hale, president; M. W. Tatlock, first vice-president; C. J. Belz, second vice-president; and C. H. Stephens, secretary-treasurer. The technical program consisted of a talk on "The Marginal Boulevard System in Dayton," given by F. J. Cellarius, life member of the Society.

District of Columbia Section—*Washington, December 13:* A record attendance of 350 was present to hear a paper on typical works constructed by the U.S. Bureau of Reclamation. This paper, which had been prepared by S. O. Harper, chief engineer of the Bureau, covered the outstanding construction projects of the Bureau from Roosevelt Dam to the present. Another drawing feature was a motion picture of the Tacoma Bridge failure, which was shown through the courtesy of the Universal Film Corporation. A report on recent developments in the national defense program was also presented.

Indiana Section—*Indianapolis, December 6:* Following a business meeting, S. M. Bailey, principal engineer and chief of the Flood Control Division of the U.S. Engineer Office at Louisville, Ky., discussed the flood control and protection program of the Corps of Engineers of the Army in the Wabash Basin and along the Ohio to the beginning of the Cincinnati District. Considerable discussion followed his talk.

Ithaca Section—*Elmira, N.Y., December 13:* Joint meeting with the Steuben Area Chapter of the New York State Society of Professional Engineers. O. J. Dempster was presented with a certificate of life membership in the Society. Then W. K. McGrath, of the New York office of the American Bridge Company, gave an illustrated talk on the Bronx-Whitestone Bridge.

Kansas City Section—*December 11:* During the annual business meeting that preceded the technical program the following new officers were elected: F. M. Cortelyou, president; W. M. Spann, first vice-president; W. G. Fowler, second vice-president; and G. G. McCaustland, secretary-treasurer. A rising vote of thanks was then given R. N. Bergendoff for his work as president. The feature of the evening was a talk on "The Effect of Inflation on Public Works," which was given by Sidney M. Cooke, cashier of the Columbia National Bank. Three short motion pictures—"Steel," "Wings over the Wonders of the World," and a film by the Bell Telephone Company—concluded the evening.

KENTUCKY SECTION—*Frankfort, December 13:* A paper on the design, construction, and failure of the Tacoma Narrows Bridge was given by H. R. Creal, bridge engineer for the Kentucky State Highway Department, and W. O. Snyder showed the news reel movies of the collapse of the structure. A round-table discussion on the design of suspension bridges was then held. The new officers for the Section are W. O. Snyder, president; C. H. Blackman, vice-president; and R. E. Shaver, secretary-treasurer.

LOS ANGELES SECTION—*December 11:* The main subject of discussion was "water." R. B. Diemer, distribution engineer for the Metropolitan Water District of Southern California, described the distribution system of the Colorado Aqueduct, illustrating his talk with slides. The Bureau of Water Works and Supply of the City of Los Angeles then presented a two-reel motion picture showing high lights of the construction of the 60-in. Stone Canyon trunk line. There was, also, a short discussion of the proposed "Engineering Professions Act." The installation of officers for 1941, announced in the January issue, concluded the program.

MARYLAND SECTION—*Baltimore, December 19:* A talk on the rôle of engineers in the national defense program was given by Maj. Gen. Julian L. Schley, Chief of Engineers, U.S. Army. Another feature of the occasion was the presentation of a certificate of life membership to Ezra B. Whitman. The other new life members from the Section—John Doyle and C. W. Thorn—were not present. The Section's officers for 1941 are Fred A. Allner, president; E. M. Killough, vice-president; and Edward S. Loane, secretary-treasurer. The latter will hold office for a two-year term.

METROPOLITAN SECTION—*December 18:* An illustrated paper on "Relation of the Rearmament Effort to the Civil Engineering Profession" was given by Col. Stuart C. Godfrey, chief of the Operations and Training Section of the Corps of Engineers, U.S. Army. Considerable discussion from the floor followed.

MICHIGAN SECTION—*Detroit, November 29:* Robert H. Merrill, consulting engineer of Grand Rapids, Mich., gave an illustrated lecture on "An Archaeological Application of Photo-Surveying at Cocle, Panama." Mr. Merrill gained his information for the talk on a recent expedition of the University of Pennsylvania Museum, which he accompanied as engineer. The expedition was engaged in recovering valuable art work from an ancient cemetery, and Mr. Merrill applied engineering principles of surveying in locating the art objects.

NEBRASKA SECTION—*December 17:* A symposium on engineering education was the feature of the occasion. Those taking part were P. J. Colbert, of the University of Nebraska; H. G. Schlitt, assistant bridge engineer of the Nebraska Department of Roads and Irrigation; and Roy M. Green, secretary of the Nebraska Examining Board.

NEW MEXICO SECTION—*Santa Fe, December 4:* Following a dinner, numerous business matters were discussed, including the activity of the Section in assisting the State Registration Board in prosecuting violations of the code. The annual election of officers resulted in the selection of the following: Burton Dwyre, president; Alan Laflin, first vice-president; W. E. Strohm, second vice-president; and Maurice Lipp, secretary-treasurer.

NORTHEASTERN SECTION—*Junior Association, Cambridge, Mass., December 12:* Following a dinner, Blake Mills, instructor in mechanical engineering at Massachusetts Institute of Technology, spoke on the subject of "The Tacoma Narrows Bridge as a Vibration Problem." A lively discussion followed this talk, which was illustrated by the use of models.

NORTHWESTERN SECTION—*Minneapolis, January 6:* After a business meeting a thirty-minute sound movie, showing some of the design and construction details of the Pennsylvania Turnpike, and a thirty-minute silent film, showing the collapse of the Tacoma Narrows Bridge, were presented.

OKLAHOMA SECTION—*Stillwater, December 14:* On this occasion the Section was entertained by the Student Chapter at the Oklahoma Agricultural and Mechanical College, and William Blanton, president of the Chapter, acted as chairman. Prof. John E. Kirkham, new recipient of life membership in the Society, reminisced concerning his experiences as a practicing engineer. The technical program consisted of a talk on construction progress to date on the Denison Dam. This was given by Capt. John Anderson, resident engineer for the Corps of Engineers, U.S. Army, on the project.

OREGON SECTION—*December 6:* C. E. Andrew, chief consulting engineer for the Washington Toll Bridge Authority, described some of the features of the design and construction of the Lake Washington Pontoon Bridge, using numerous slides for illustrations. Mr. Andrew also spoke on the failure of the Tacoma Narrows Bridge, and a general discussion followed.

PANAMA SECTION—*Balboa, C.Z., January 10:* The largest attendance on record turned out to hear an illustrated lecture on the Tacoma Bridge failure. The prominent guests present included Brig. Gen. Glen E. Edgerton, governor of the Panama Canal. Discussion of the lecture was led by Charles F. Goodrich.

PHILADELPHIA SECTION—*December 10:* Secretary George T. Seabury was the guest of the Section and presented certificates of life membership to the six of the twelve recipients who were able to attend the meeting. The first speaker on the technical program was Frank H. Jackson, senior engineer of tests for the Public Roads Administration, whose subject was "Recent Trends in Specifications for Portland Cement." Following some discussion from the floor, Stanton Walker, director of engineering for the National Sand and Gravel Association, spoke on the design of concrete mixtures.

PITTSBURGH SECTION—*November 11:* Joint meeting with the Civil Section of the Engineers' Society of Western Pennsylvania. The speaker of the evening was Arthur J. Boase, manager of the Structural and Technical Bureau of the Portland Cement Association, Chicago, who discussed the use of concrete in bridges, buildings, and highways, which he studied during a tour of Europe. His address was illustrated with lantern slides. *December 18:* Joint meeting with the Civil Section of the Engineers' Society of Western Pennsylvania and the Pittsburgh Post of the Society of American Military Engineers. An illustrated talk on national defense was given by Capt. Paul W. Thompson, of the Intelligence Division, Office of the Chief of Engineers, U.S. Army.

SACRAMENTO SECTION: Five meetings held during the month of December included a business session, the annual "Christmas Jinx," and a symposium on engineering education. The speaker on the latter subject was Leonard Hollister, chairman of the Engineering Education Committee of the State Employees Association. Entertainment at two of the meetings consisted of the showing of motion pictures—on the Central Valley Project, the Death Valley National Monument, and the manufacture of plywood (the latter furnished through the courtesy of the Douglas Fir Plywood Association). *Junior Association, December 11:* W. J. Parsons, associate hydraulic engineer in the U. S. Engineer Office in Sacramento, spoke on the physiography of rivers.

ST. LOUIS SECTION—*December 6:* Senior-class engineering students from the University of Missouri, the Missouri School of Mines and Metallurgy, and Washington University were dinner guests of the Section on this occasion. During the business session the following officers were elected for the new year: F. C. Woermann, president; Hymen Shifrin and L. B. Feagin, vice-presidents; and M. Buchmueller, secretary-treasurer. W. R. Crecelius was elected councillor, and R. A. Willis carries over as councillor from last year. Four members of the Section—J. E. Conzelman, H. M. Cryder, A. P. Greensfelder, and C. M. Talbert—were presented with certificates of life membership by Director Robert B. Brooks. Then James L. Ferebee, Vice-President of the Society, discussed the activities of the Society. The speaker of the evening was Carl C. Mose, instructor in the Washington University Art School, who lectured on "The Engineering of a Statue," illustrating his remarks with clay modeling.

SAN DIEGO SECTION—*November 28:* A geologist for the Standard Oil Company discussed his experiences as a geologist in Iran. The members found this talk particularly interesting because it was by a technical man with a wide classical background. The Section announces that its officers for 1941 are C. Wayland Capwell, president; Norman Mc Lean, vice-president; and Lorin W. Deewall, secretary-treasurer.

SAN FRANCISCO SECTION—*November 20 and December 17:* The November meeting was a special session called for the purpose of enabling members to hear Dr. Nathan A. Bowers, Pacific Coast editor of the *Engineering News-Record*, give an illustrated lecture on the Tacoma Narrows Bridge disaster. The feature of the an-

nual dinner meeting, held in December, was the presentation of certificates of life membership to members of the Section. The technical program on that occasion consisted of a talk by Ralph A. Tudor, principal bridge engineer for the San Francisco–Oakland Bay Bridge Administration, who discussed "Financing Vehicular Ways by Tolls." *Junior Forum, November 25:* A talk on the regulation of public utilities was given by John C. Luthin, engineer for the California Railroad Commission. The topic for open discussion was "Is Civil Engineering Still a Profession?"

TACOMA SECTION—*December 10:* Business discussion occupied the entire session. The new officers, announced at this time, were reported in the January issue of CIVIL ENGINEERING. An informal smoker and card party concluded the evening.

TENNESSEE VALLEY SECTION—*Chattanooga Sub-Section, December 10:* A symposium on concrete design specifications was the feature of the occasion. Those taking part were O. H. Raine, C. D. Durfee, J. M. Hayes, P. B. Allen, W. N. Downey, W. G. S. Saville, Everett Scroggie, and M. A. Roose. The newly elected vice-president, Felix Truss, was welcomed to the chair, and F. E. Junior was elected secretary-treasurer of the Sub-Section.

TOLEDO SECTION—*December 18:* During the annual business meeting the following officers were elected for 1941: R. A. Nyquist, president; R. W. Abbott, vice-president; and W. P. Sanzenbacher, secretary-treasurer. H. A. Stepleton automatically continues in office as vice-president for the coming year. Lt. Col. Wiley H. O'Mohundro, acting executive officer of the Toledo Engineer District, addressed the Section on the subject of "The Government's Task in the Present Emergency." Mr. Nyquist concluded the evening with a report on the Local Sections Conference held in Cincinnati in October.

TRI-CITY SECTION—*December 19:* James L. Ferebee was the principal speaker at this gathering. As Vice-President from Zone III, Mr. Ferebee discussed Society affairs briefly. Then, in his capacity as chief engineer and general manager of the Milwaukee Sewerage Commission, he delivered an address on "The Metropolitan Sewerage District of Milwaukee."

UTAH SECTION—*December 6:* During this session L. M. Winsor was elected president of the Section for the coming year; George H. Taylor, first vice-president; and Harold R. Kepner, second vice-president. F. H. Richardson was reelected secretary-treasurer. Then Col. Ralph Royce, commanding officer of the Seventh Bombardment Group of the Army Air Corps, spoke on "Modern Aviation."

VIRGINIA SECTION—*Roanoke, December 14:* Following a luncheon, the afternoon was devoted to discussing ways and means of furthering the activities of the Section in the western part of the state. The possibility of a sub-section was brought up, as was the formation of an engineers' club in Roanoke. After considerable discussion the matter was referred to a committee, under the chairmanship of E. S. Thomas, for study and report.

WISCONSIN SECTION—*Milwaukee, December 12:* The meeting was devoted almost entirely to business discussion. The annual election of officers resulted as follows: C. A. Willson, president; B. E. Brevik, first vice-president; H. H. Brown, second vice-president; and Lloyd D. Knapp, secretary-treasurer. Mr. Willson was then introduced and made a few remarks appropriate to the occasion.

WYOMING SECTION—*Cheyenne, December 19:* Joint dinner meeting with the Cheyenne Engineers' Club. The speaker and guest of honor was Ewing T. Kerr, attorney general for Wyoming, whose subject was "Interstate Water Litigation." Other guests included Ralph Parshall, newly elected president of the Colorado Section, and N. A. Christensen, dean of engineering at Colorado State College.

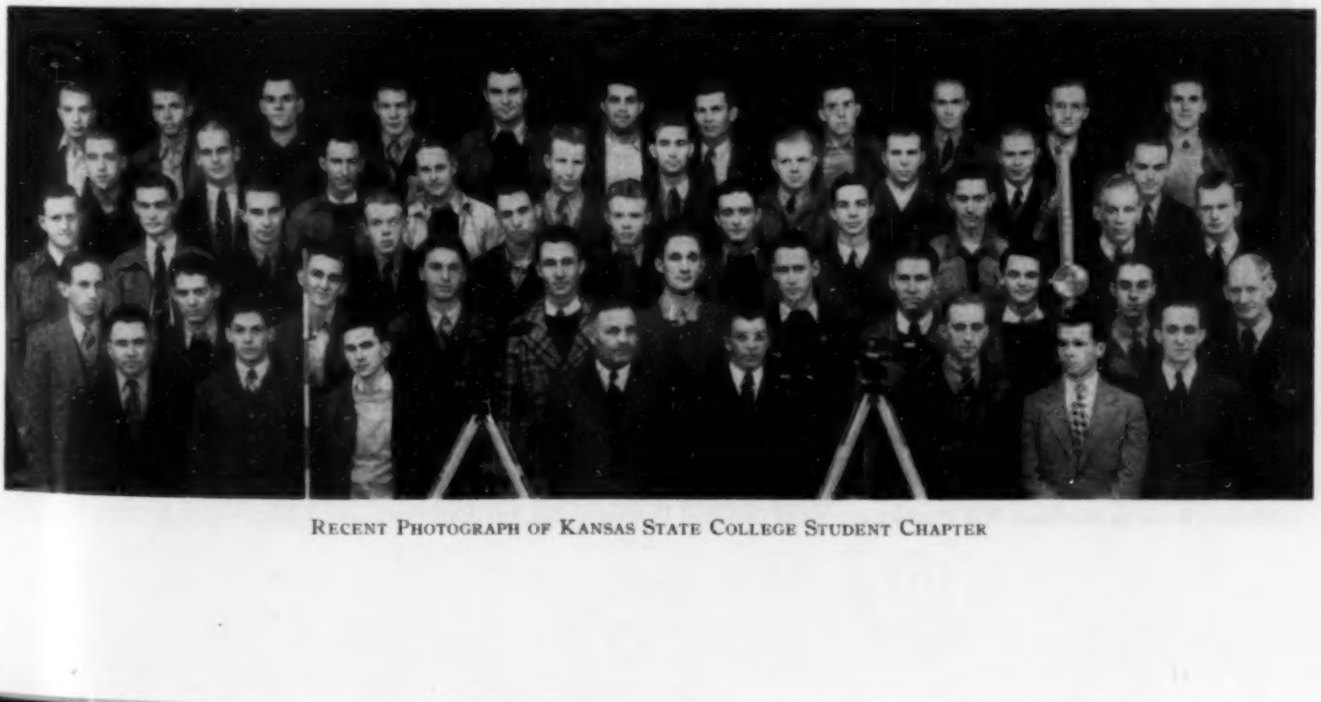
Student Chapter Notes

COLLEGE OF THE CITY OF NEW YORK—*December 12:* On this occasion members of the Chapter made an inspection trip to the fabricating plant of the Bethlehem Steel Company at Pottstown, Pa. The group was conducted through the whole plant and had an opportunity to see the actual fabricating of the steel work for the new Rainbow Bridge at Niagara Falls, N.Y.

KANSAS STATE COLLEGE—*December 17:* The annual fall smoker took place on this date. The members were greeted by M. H. Davison, Junior Contact Member for the Chapter, who gave a brief talk. Then H. W. Brubaker, professor of chemistry at Kansas State College, spoke on the purification and treatment of the domestic water supply. A social hour and supper concluded the evening.

MANHATTAN COLLEGE—*November 13, December 11, and January 8:* The speaker at the first of these meetings was Harold Faber, research chemist for the Chlorine Institute, who discussed "Chlorine and Its Uses." At the December meeting the Society's slides on Mississippi River flood control were shown by James Fawls, vice-president of the Chapter. A member of the staff of the U.S. Weather Bureau addressed the group at the last of these sessions on the work of the Bureau.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—*November 23 and 24:* On the evening of the 23rd members of the Chapter who attended the M.I.T. surveying camp in Maine for the past two summers gathered for a banquet and reunion. Civil engineers at M.I.T. always spend the summer of their junior year at the camp, and during the past few years they have been joined by men from the Newark College of Engineering and several other colleges. On the 24th the group spent the afternoon at the museum and laboratories of William F. Clapp, consulting biologist of Duxbury, Mass., where they learned about marine borers. Mr. Clapp has a collection of marine borers from all parts of the world and has done pioneer work in this important field.



RECENT PHOTOGRAPH OF KANSAS STATE COLLEGE STUDENT CHAPTER

ITEMS OF INTEREST

About Engineers and Engineering

Finding Your Place in the Army

Classification Procedure Used at Reception Centers Facilitates Appropriate Assignment of Draftees

ONE of the very personal and important questions that every young engineer selected for training and service in the armed forces of the United States will ask is, "What Army unit can utilize my training and experience to the best advantage of the government?"

According to Gen. George C. Marshall, Chief of Staff of the Army, the plans and policies with reference to the induction of selectees with engineering experience, and the proper utilization of their engineering abilities during their period of training and service in the Army have been given ample consideration in the War Department. A well-thought-out plan has been developed and put into use.

As he passes through a reception center, each selectee is classified, and the facts pertaining to his civil profession or occupation and experience, including his education, are recorded on what is known as the "soldier's qualification card," reproduced in Fig. 1. On this 8 by 10-in. card, expert interviewers record data obtained from the selectee. The cards are coded by experienced classifiers, and then form the basis for the selection and assignment of the enlisted man to a unit of the type that best fits the capabilities of the individual and serves the best interests of the Army. The card is a permanent part of the selectee's record and it goes with him wherever he is assigned, so that subsequent entries may further classify him as to his progress and skill.

During the World War, before the problem of sorting man-power was solved, one Division was disrupted as many as four times by transfers of men of certain qualifications to other organizations. The lost time, lost effort, confusion, and discouragement caused by failures to sort out personnel before assignment made it necessary to develop measures to remedy the situation.

During this major mobilization, a heterogeneous assortment of man-power will be received by the Army. In order to lift a great burden from the combat unit and to aid the rapid attainment of combat efficiency, the sorting process is being accomplished in reception centers before the assignment of men to organizations. Army replacement centers and organization schools will train personnel for every military need left unsupplied by civilian experiences, but the Army must avoid useless training such as the training of surveyors to be truck drivers in one place and truck drivers to be surveyors in another.

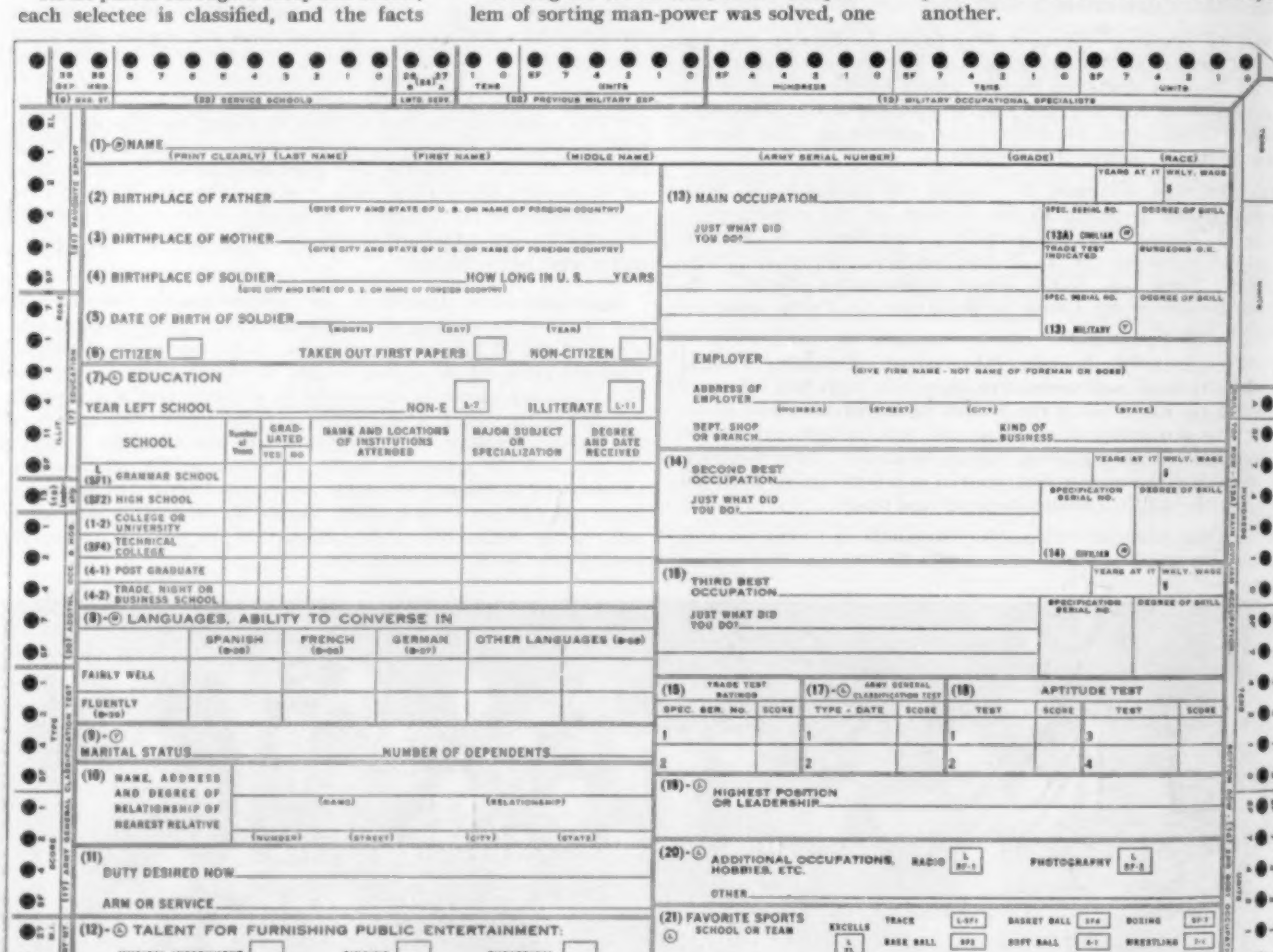


FIG. 1. THE SOLDIER'S QUALIFICATION CARD

Modern Business Machines Will Produce Record of Qualified Draftee to Fill Any Experience Need After Coded Answers Are Filed

Induction Station

A registrant's first contact with military service has been his registration by his civilian local selective service board. These boards assemble and transport to induction stations registrants who have been called. The function of the induction stations is to provide the final physical examination for a registrant selected for induction, and the induction into the service of all those acceptable to the Army. There is to be at least one induction station in every state and from nine to twelve stations in each corps area. Selective service provides the transportation necessary from the selectee's home to the induction station. As many as two hundred men per day will be examined at any one induction station. All selectees who successfully pass the physical examination are immediately inducted into the Army by taking the oath of service and by having their obligations and privileges explained to them by a commissioned officer.

Classification in Reception Center

Those inducted into the service are being sent to reception centers for the purpose of classification so that the best possible disposition of available skill can be made. Here clothing is issued, and vaccination and other immunization procedures are given in order to relieve the organization to which the men will be assigned of the administrative burden connected with transforming civilians into enlisted men. Upon arrival at the reception center each soldier is supplied with a service record, an extract from the selective service questionnaire, and the soldier's qualification card, Fig. 1. The soldier will then be given the Army's general classification test, and an occupational interview.

The purpose of classification is to obtain and record in a readily usable form information concerning the man's qualifications as to education, aptitude, previous military experience, and civilian occupational skills. Interviewers are carefully selected and charged with the seriousness and importance of their duty. It is serious to the enlisted man and important to the full success of the Army. Fundamentally the classification of personnel in the Army is to be thought of as a "search for talent" in Army needs. Interviewers are trained in friendly conversational methods so that selectees will be encouraged to give the full information necessary to a complete understanding of their entire occupational education and military experience. One of the questions asked of each enlisted man is the duty he would most like to have in the Army. He may indicate, also, his choice as to arm or service. If he makes a choice it is recorded in the appropriate space—item No. 11 in the soldier's qualification card.

When the occupation interview has been completed, the soldier's qualification card is forwarded to the chief interviewer, to the classifier, and in turn to the code clerk who punches the selection holes around the margin of the card. This card is to be used in every post or camp of the Army wherever the enlisted man may be stationed. Even after his discharge from the Army and after his active military service terminates, it is available for use in placing him in civil life.

Engineers as Leaders

Although such may not always be the case, it is essential that the Army draw from the selectees with engineering experience those who have a high capacity for leadership for use in all the combat arms as leaders. Men with engineering experience are desired especially for the technical arms and services.

Present plans are that until March 1 the greater number of engineers and engineering students selected for training and service will be assigned to engineer units, and, thereafter, to the Engineer Replacement Center at Fort Belvoir, Va., and to the Seventh Corps Area Training Center (recently named Fort Leonard Wood) at Rolla, Mo., for training.

Officer's Training Camps

The War Department wishes to discover every qualified engineer obtained under selective service and to place him in some unit of engineers, artillery, the armored force, ordnance, quartermaster construction, or in some other technical branch where his technical knowledge and experience and his capacity for leadership will be of greatest advantage to the government.

The War Department expects to provide for selectees who demonstrate outstanding ability in any arm or service in the form of additional training in an officer's training camp to qualify them for commissions in the Army.

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

"I hope," said Professor Neare at the February meeting of the Engineers' Club, "that none of you lost any sleep working the navigator's problem. If the path of the U.S.S. *Pivot* was

$$y = 0$$

then the encompassing path of the U.S.S. *Swing* was

$$x = \frac{1}{1-k^2}\left[\sqrt{c^2 - y^2} + kc\,E\left(k, \operatorname{arc}\cos\frac{y}{c}\right)\right]$$

where c was the constant interval between the *Swing* and the *Pivot*, k was the ratio of *Pivot's* speed to *Swing's* and $E(\,)$ is an elliptic integral of the second class. At the start and again an hour later, $y = c = 5$, and x increases from 0 to 20, so

$$20 = \frac{5k}{1 - k^2}\,E(k, 2\pi) = \frac{20kE}{1 - k^2}$$

$$\frac{1 - k^2}{k} = E = \frac{\pi}{2}\left(1 - \frac{k^2}{4} - \frac{3k^4}{64} - \frac{5k^6}{256}\cdots\right)$$

Using the first two terms of the series, and Horner's method,

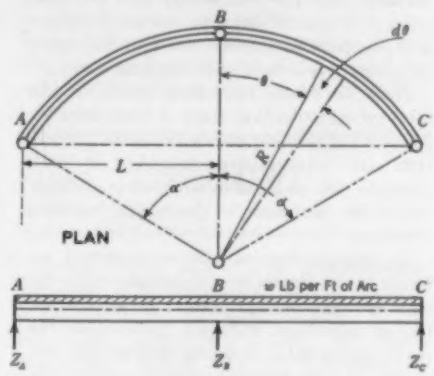
$$\pi k^3 - 8k^2 - 4\pi k + 8 = 0$$
$$k = 0.506$$

and the U.S.S. *Swing* had to run at $20/0.506 = 39.5$ knots (39.43 if we use four terms of the series). Considering this schedule and its path, the *Swing* had to swing right along and make knots in more ways than one.

"Which reminds me that this evening I have brought a naval officer for our 'Guest Professor.' Commander Wise, you are invited to intrigue, mystify, or confound the Club, but I warn you, Wise as you are, we don't ask odds."

"Nor do I, Professor, particularly as my problem is a paradox that I hope all will solve. In fact, I'll perform all the mathematical work and get the wrong answer, then ask the Club to point to my mistake.

"Several years ago I designed a balcony beam of constant section along a horizontal circular arc. I have illustrated the design dimensions (Fig. 1); note that the beam was simply supported at points A, B, and C and that the design load was assumed uniformly distributed along the arc.



"First I took moments about chord AC to find Z_B, the reaction at B, thus:

$$Z_B R(1 - \cos\alpha) = 2\int_0^\alpha wR^2(\cos\theta - \cos\alpha)d\theta$$
$$= 2wR^2(\sin\alpha - \alpha\cos\alpha)$$

$$Z_B = 2wR\,\frac{\sin\alpha - \alpha\cos\alpha}{1 - \cos\alpha}\,\ldots\ldots\ldots\ (1)$$

"For a check, I let R increase infinitely, holding the chord constant, so that α approached zero as a limit and the beam approached a straight beam continuous over two spans. In the form above, Eq. 1 is indeterminate, but I evaluated the limit with the help of series expansions, viz,

$$Z_B = 2wR \times \frac{\left(\alpha - \frac{\alpha^3}{6} + \frac{\alpha^5}{120}\cdots\right) - \alpha\left(1 - \frac{\alpha^2}{2} + \frac{\alpha^4}{24}\cdots\right)}{1 - \left(1 - \frac{\alpha^2}{2} + \frac{\alpha^4}{24}\cdots\right)}$$

$$= 2wR\,\frac{\alpha^3\left(\frac{1}{3} - \frac{\alpha^2}{30}\cdots\right)}{\alpha^2\left(\frac{1}{2} - \frac{\alpha^2}{24}\cdots\right)}$$

$$= 2wR\alpha\,\frac{\frac{2}{3} - \frac{\alpha^2}{15}\cdots}{1 - \frac{\alpha^2}{12}\cdots}\,\ldots\ldots\ldots\ (2)$$

"As α approaches zero as a limit, the terms in α^2 become negligible and $R\alpha$ approaches L as a limit, hence,

$$Z_B = \frac{4}{3}wL\,\ldots\ldots\ldots\ (3)$$

"But we accept for the middle reaction of two equal-span, uniformly loaded continuous beams, the formula,

$$Z_B = \frac{5}{4} wL \quad \ldots\ldots\ldots\ldots (4)$$

"So I propose that you explain for me the paradox between Eqs. 3 and 4 and determine the validity of Eq. 1."

Civil Engineering for March

DETAILS of procedure in organizing for and designing shelters to protect civilians from air-raid attack is the subject of a paper by Joseph Lewin. The information comes as a by-product of the work of the Society's defense committee and contains enough essential data to orient designers and planners with respect to suitable types of construction and approximate costs.

How to evade becoming stuck in the mud on construction work is explained by Jacob Feld in a summary of useful expedients for overcoming troubles in soft ground. He deals also with other difficulties to be overcome in the heavy building industry.

In recognition of the widespread interest in the Baton Rouge cantilever bridge over the Mississippi River, E. L. Durkee has prepared an intimate account of the procedure used in floating steel to the site, of the various hoisting devices, and of the various techniques used in balancing and closing the spans. He explains the uses of a "falsework bent."

In contrast to the Baton Rouge bridge, on which construction was virtually begun in the middle, temporary bridges built by troops under fire are usually put together as completely as possible on the shelter of the bank. Major E. P. Lock, Jr., presents a description of the combat crossing methods currently practiced by the Corps of Engineers.

Triangulation for a large construction project, influence of sewage deposits on stream qualities, and some basic considerations of open-channel hydraulics are other subjects tentatively planned for inclusion in the March issue.

Active Duty Roster Grows

PREVIOUS ISSUES of CIVIL ENGINEERING have listed members of the Society in the Officers Reserve Corps of the Army and in the U.S. Naval Reserve, who have been ordered to active duty. Additional changes of this sort in the Officers Reserve Corps of the Army include Lt. Col. C. E. Myers from consulting engineer of Philadelphia, Pa., to the Quartermaster Corps of the Army, with headquarters in Philadelphia; Maj. Earl F. Ketcham from field engineer for the PWA at Kearney, Nebr., to the Corps of Engineers, 2d Military Area, Omaha, Nebr.; Capt. Charles B. Bull from field engineer for the WPA in New York to the Office of the Quartermaster General, assigned to the new construction program at Picatinny Arsenal, Dover, N.J.; Capt. Lewis J. Workman from associate engineer for the U.S. Bureau of Reclamation at Denver, Colo., to executive officer with the Constructing Quartermaster at Camp Hulen, Tex.; Lt. A. A. Faxon from projects inspector for the New Jersey State Highway Department at Trenton, N.J., to Fort Dix, N.J., where he is Reception Center Quartermaster; Lt. John E. Healy from Philadelphia to Camp Upton, Yaphank, L.I.; Lt. Robert M. Lingo from instructor in civil engineering at the University of Maryland to engineer officer on duty with the Constructing Quartermaster at Southeast Air Depot, Mobile, Ala.; Lt. Loyal M. Nerdahl from maintenance engineer at Lake Mohonk Mountain House, Lake Mohonk, N.Y., to the Engineer School at Fort Belvoir, Va.; and Lt. Willard S. Sitler from sanitary engineer for the St. Joseph County Health Department at Centerville, Mich., to the 21st Engineers at Langley Field, Va.

Of the Naval Reserve there are Comdr. Vernon R. Dunlap from superintendent of the Overbrook Steam Heat Company at Philadelphia, Pa., to the Bureau of Yards and Docks in Washington, D.C.; Comdr. George F. Nicholson from consulting engineer of Los Angeles, Calif., to the Eleventh Naval District embracing Southern California; Lt. Comdr. Stanley T. Barker from assistant sanitary engineer for the New York State Department of Health at Albany, N.Y., to the Navy Building, Washington, D.C.; Lt. Comdr. William W. Wannamaker from president of Wannamaker and Wells, Inc., Orangeburg, S.C., to the Marine Barracks at Parris Island, S.C.; Lt. Eugene J. Peltier from resident engineer for the Kansas State Highway Commission at Ottawa, Kans., to the Naval Training Station at Great Lakes, Ill.; Lt. James B. Robinson from structural engineer for United Consulting Engineers, Inc., Washington, D.C., to the Fourteenth Naval District at Pearl Harbor, T.H.; and Lt. Arthur T. Roth from assistant engineer for the U.S. Soil Conservation Service at Kittanning, Pa., to the Bureau of Yards and Docks in Washington, D.C.

Brief Notes

TESTS for Intoxication is the subject of a 1940 report by a committee of the National Safety Council, 20 North Wacker Drive, Chicago. Suggestions for preliminary activity in setting up a scientific program for handling intoxicated drivers and pedestrians are included with technical data on test methods.

* * * *

THE Fourth Texas Conference on Soil Mechanics and Foundation Engineering will be held at the University of Texas on February 21 and 22.

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TO ACCELERATE the defense program, Revere Copper and Brass, Inc. announces a competition for suggestions submitted by American workmen in the metal industry. Nine cash prizes, totaling $10,000, will be awarded. Entries close April 30, 1941. For information write to the Revere Award, Box 1805 Washington, D.C.

NEWS OF ENGINEERS

Personal Items About Society Members

FREDERICK G. SWITZER recently resigned as professor of mechanics and hydraulic engineering and head of the department of mechanics at Cornell University in order to become division engineer with the New York City Board of Water Supply.

JACK J. HINMAN, JR., associate professor of sanitation at the University of Iowa, has reported for duty at Fort Belvoir, Va., as lieutenant colonel in the Chemical Warfare Service of the National Guard.

WILLIAM C. WEEKS, of Bridgeport, Conn., who retiredf rom active army service five years ago with the rank of colonel, has been recalled to duty and made district engineer for the Corps of Engineers at Jacksonville, Fla.

FREDERICK E. SCHMITT has resigned as editor of *Engineering News-Record* and will serve as staff consultant to the U.S. Bureau of Reclamation in both the Washington and Denver offices. Mr. Schmitt has been on the editorial staff of *Engineering News-Record* and its predecessor, *Engineering News*, for thirty-eight years—for the past ten years as editor.

O. LAURGAARD announces the opening of a consulting office in the Bedell Building (Room 1015), Portland, Ore., where he will be available for work on irrigation, power, flood control, navigation, municipal, highway, railway, and miscellaneous projects. Until recently Mr. Laurgaard was engineer for the TVA on the construction of Hiwassee Dam in North Carolina.

A. M. RAWN, assistant chief engineer of the Los Angeles County Sanitation Districts, has been appointed chief engineer to fill the vacancy caused by the death of A. K. WARREN.

CARL H. COTTER, commander, Civil Engineering Corps, U.S. Navy, has been transferred from Jacksonville, Fla., where he was in charge of construction of the Naval Air Station, to Norfolk, Va. Commander Cotter will be public works officer at the Norfolk Naval Operating Base.

CHARLES KELLER, who retired from the U.S. Army in 1923 with the rank of brigadier general, has been ordered into active service as district engineer in charge of the Chicago area. For the past several years he has been consultant for the Public Utility Engineering and Service Corporation, of Chicago.

M. E. GILMORE has been appointed Commissioner of Public Works, in Washington, D.C., succeeding E. W. CLARK, who is now with the Bureau of the Budget. Until recently Colonel Gilmore was regional director of Region 1 of the PWA, with headquarters in New York City.

DON JOHNSTONE, former editor of CIVIL ENGINEERING and more recently

assistant professor of civil engineering at Ohio State University, is now on active duty with the Civil Engineer Corps of the Navy. His assignment is with the Bureau of Yards and Docks, Washington, D.C.

Theodore T. McCrosky, formerly director of planning for the New York City Department of Planning, has been made executive director of the Chicago Plan Commission.

L. A. Larson is now junior naval architect for the Philadelphia Navy Yard. He was previously assistant superintendent on general construction for the Larson Building Company at Ambridge, Pa.

Merton R. Keefe has resigned as chief engineer of the Indiana State Highway Commission in order to join the Russel B. Moore Engineering Company as chief engineer of the new naval ammunitions storage depot located at Burns City, Ind.

George A. Sedgwick has severed his connection with the California State Division of Architecture in order to accept a position as associate engineer with the Panama Canal Commission.

Ralph A. Tudor, principal bridge engineer of maintenance and operation of the San Francisco-Oakland Bay Bridge, has been granted leave of absence to serve in the National Guard, with the rank of lieutenant colonel. He will be stationed at San Luis Obispo as assistant to the Chief of Staff in charge of military intelligence of the General Staff of the Fortieth Division.

Eric Haquinius is now associated with the consulting firm of H. B. Gieb and Associates, of Dallas, Tex. He was formerly connected with the Brazos River Conservation and Reclamation District at Mineral Wells, Tex.

Edwin H. Blaschke has resigned as assistant job engineer for the Lower Colorado River Authority in order to accept a position in a similar capacity with the Foundation Company of New York. He is located at Quincy, Mass., where his company is building drydock slips and a wet basin for the Bethlehem Steel Company.

William L. Stone, Jr., previously rodman for the Caye Construction Company, Inc., of Brooklyn, N.Y., is now employed as a chainman on maintenance of way in the River Division of the New York Central Railroad.

Frank H. Shaw, civil engineer of Lancaster, Pa., has been appointed supervising engineer for the Reconstruction Finance Corporation on the construction of an airplane manufacturing plant for North American Aviation Inc., near Dallas, Tex.

James Wilmot is now project engineer for the Caribbean Architects and Engineers, Port of Spain, Trinidad, B.W.I. He was formerly park director for the New York City Parkway Authority.

Arthur M. Shaw announces that he is building his second army camp at Alexandria, La. His first was built in 1917 when he was Constructing Quartermaster, while this time he is chief engineer for the general contractor, the W. Horace Williams Company.

I. L. Tyler is now research engineer for the Portland Cement Association, engaged on the long-time study of cement performance in concrete. His headquarters are in Chicago, Ill. He was formerly with the Pennsylvania Turnpike Commission.

Thomas J. Sette recently resigned as junior inspector for the Texas State Highway Department in order to accept a position as engineering draftsman in the Highway and Railroad Division of the TVA. He is located at Chattanooga, Tenn.

Arthur R. Lord has left his position as assistant state administrator for the WPA of Illinois in order to become connected with a new section of the Bureau of Yards and Docks, U.S. Navy Department, Washington, D.C. His work will consist of cost and speed control on all the contracts of the Bureau.

C. Stuart Duggins, previously resident engineer inspector for the PWA at Richmond, Va., has been appointed building inspector for the City of Richmond.

Norman P. Henderson is city engineer of Yonkers, N.Y. He was formerly deputy city engineer.

Rudolf P. Forsberg has been retired as chief engineer of the Pittsburgh and Lake Erie Railroad Company, with headquarters in Pittsburgh, because of having reached the age of seventy. Mr. Forsberg had been in the continuous service of the engineering department of that Company since September 1892, and before going there was with the Norfolk and Western.

James S. Sweet, until recently acting hydrologic supervisor of the North Atlantic Region of the U.S. Weather Bureau at Albany, N.Y., has been designated hydrologic supervisor of that region.

John W. Ruddy, formerly junior civil engineer for the Pennsylvania WPA, with headquarters at Williamsport, Pa., has accepted a position as civil engineering draftsman in the U.S. Engineer Office at Vicksburg, Miss.

Ralph H. Chambers, consulting engineer of New York City, has been appointed vice-president of the Foundation Company, of New York.

Ralph M. Palmer, assistant engineer for the City of Duluth, has been named superintendent of the municipality's new sewage disposal plant, which will be put into operation soon.

J. Wm. Moffett is now with Giffels and Vallet, Inc., of Detroit, Mich. Until lately he was chief structural engineer for the United Engineers and Constructors, Inc., of Philadelphia, Pa.

Harry M. Freeburn has resigned as district engineer for the Pennsylvania State Department of Health, with headquarters in Philadelphia, to become chief engineer for the Philadelphia Suburban Water Company. Mr. Freeburn has been connected with the State Department of Health for twenty-five years.

Frank S. Farquhar, who is on the staff of the U.S. Coast and Geodetic Survey, has been transferred from Boston, Mass., to Washington, D.C., where he holds the position of junior nautical scientist.

John A. Walls has severed his connection with the Safe Harbor Water Power Corporation, but will continue as president of the Pennsylvania Water and Power Company, of Baltimore, Md.

James I. Ballard, after six years as editor of *Western Construction News*, has returned to the Staff of *Engineering News-Record* in the capacity of managing editor. His headquarters are in New York. Mr. Ballard first became connected with the *Engineering News-Record* in 1929, and he served it in various capacities until 1935.

DECEASED

John Segar Allen (M. '24) engineer inspector for the PWA at Worcester, Mass., died on November 30, 1940, at the age of 69. From 1902 to 1916 Mr. Allen was with Norcross Brothers Company of Worcester on various construction projects, and from 1916 to 1921 structural engineer for the Norton Company of Worcester. Later he was resident engineer for the state of Connecticut on the construction of a normal school at New Britain, Conn., and for some years served the PWA on various construction projects throughout the country.

Frederick Luther Ford (M. '05) president of Ford Brothers, Inc., of New Haven, Conn., died there on December 18, 1940. He was 69. From 1902 to 1911 Mr. Ford was city engineer of Hartford-Conn., and from 1912 to 1920 city en, gineer of New Haven. Since 1926 he had been a fuel oil distributor in partnership with his brother. He had served in both the Connecticut legislature and the state senate.

Alan Washburn Holliday (Jun. '36) instructor in civil engineering at the University of Wyoming, died on November 30, 1940, at the age of 25. Mr. Holliday received his engineering degree from the University of Wyoming in 1936, and he had been in the office of the city engineer of Laramie and junior engineer for the U.S. Bureau of Reclamation at Berkeley, Calif., before joining the staff of the university.

William Atlee James (M. '09) of Lydiatt, Man., Canada, died on July 3, 1940, at the age of 76. An American by birth, Mr. James went to Canada in 1898 on construction work for the Canadian Pacific Railway, and remained with that organization for the rest of his professional career. At the time of his retirement in 1932 he was assistant chief engineer.

SAMUEL KLEIN (Assoc. M. '12) consulting civil engineer of Chicago, Ill., died in that city on December 5, 1940. He was 56. Early in his career Mr. Klein was with the Trussed Concrete Steel Company, of Detroit. Later he worked for the Chicago, Milwaukee and St. Paul Railroad, and then was active in organizing the firm of Lieberman and Klein. He was engaged on the construction of many large buildings throughout the country.

EDGAR ALVA NORWOOD (Assoc. M. '16) of the firm J. R. Worcester and Company, of Boston, Mass., died on September 23, 1940. Mr. Norwood, who was 56, became connected with J. R. Worcester and Company in 1907, shortly after his graduation from Tufts College, and remained there for the rest of his life. He aided in the design of various important buildings in Boston, the Peabody Museum at Harvard, and the Boston Elevated Railway.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

JOHN MARBLE RACE (Assoc. M. '02) resident engineer inspector for the PWA at Enfield, Mass., died on November 27, 1940. For some years Mr. Race maintained a practice as consulting engineer and landscape architect (Barnes and Race) at Pittsfield, Mass., and later served as resident engineer for the District of Azua Department of Public Works in the Dominican Republic.

CHARLES HENRY SMITH (M. '36) of Portland, Ore., died in that city on December 20, 1940, at the age of 72. From 1898 to 1907 Mr. Smith was designing and construction engineer for the Hawaii Department of Public Works, and from 1910 to 1916 chief inspector of sewer construction for Portland. In the latter year he was appointed sewer engineer for the city and, except for five years as project engineer for Baar and Cunningham of Portland, continued in this capacity until December 1939 when illness forced his retirement.

KENNETH CRAWFORD WRIGHT (M. '29) manager of the Industrial Equipment Division of the Lang Company, Salt Lake City, Utah, died there on December 21, 1940. He was 49. Mr. Wright spent most of his career—1916 to 1939—with the Utah State Road Commission, serving successively as designer, resident engineer, construction engineer, district engineer, assistant chief engineer, and (for five years) chief engineer.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From December 10, 1940, to January 9, 1941, Inclusive

ADDITIONS TO MEMBERSHIP

ABBOTT, DONALD (Jun. '40), Draftsman, Geo. A. Fuller Co. & Merritt, Chapman & Scott Corp., Naval Air Base, Quonset Point, R.I.

ACETI, JOHN GABRIEL (Jun. '40), Soils Insp., State Highway Dept., Kalamazoo County Bldg. (Res., 1003 Clinton Ave.), Kalamazoo, Mich.

AKINS, JOHN CRIGHTON (Jun. '40), With Standard Oil Co. of Indiana (Res., 2008 Lake Ave.), Whiting, Ind.

AUER, JEROME LEO (Jun. '40), With State Highway Dept., 1246 University Ave. (Res., 1675 Roblyn), St. Paul, Minn.

AUSTIN, CLEMONT ROBERT, JR. (Jun. '40), With Field Staff, Turner Constr. Co., 420 Lexington Ave., New York, N.Y. (Res., 3856 Beech Ave., Erie, Pa.)

BAIRD, RALPH WALDO (Assoc. M.'40), Hydr. Engr., U.S. Dept. of Agriculture, Federal Bldg., Waco, Tex.

BARTZ, ELLWOOD LEWIS (Jun. '40), With War Dept., U.S. Engr. Office, Pier 2A, Ft. of Channel St., Honolulu, Hawaii.

BEAM, WALTER MYERS (Jun. '40), Technical Engr., State Highway Comm., State House Annex, Indianapolis, Ind.

BEARD, ARTHUR HORNELL, JR. (Jun. '40), With Charles H. Hurd, 333 North Pennsylvania St. (Res., 945 North Campbell Ave.), Indianapolis, Ind.

BEGG, JAMES CURRIE (Jun. '40), Asst. Building Insp., City of Roanoke, Room 3 Municipal Bldg. (Res., 504 Greenwood Rd.), Roanoke, Va.

BELL, AMBROSE PETER (Jun. '40), Engr., Development Dept., Kelly-Springfield Tire Co. (Res., 64 Greene St.), Cumberland, Md.

BERRY, CHARLES VALENTINE (M. '40), Precast Unit Co., 2129 East Michigan Ave., Kalamazoo, Mich.

BESHERS, HUGH MONAHAN (M. '40), Div. Supt., Lago Oil & Transport Co., Aruba, Curacao.

BINGHAM, GEORGE STORRS (Jun. '40), Care, Design and Appraisal Div., Ebasco Services Inc., 2 Rector St., New York, N.Y.

BLACK, CHARLES DUNBAR (Jun. '40), 76 B. Smith St., Charleston, S.C.

BLESSEY, WALTER EMANUEL (Jun. '40), Rodman, United Gas Pipe Line Co., Box 296, Iowa (Res., 616 Nashville Ave., New Orleans), La.

BROWN, WENDELL STIMPSON (M. '40), Chf. Engr., F. P. Sheldon & Son, 1038 Hospital Trust Bldg. (Res., 201 Wentworth Ave., Edgewood), Providence, R.I.

CABELL, JOHN BELL (Jun. '40), Instr., Virginia Military Inst., 422 V.M.I. Parade, Lexington, Va.

CASEY, JOHN JOSEPH, JR. (Jun. '40), Stress Analyst, Curtiss-Wright Aeroplane Div., Kenmore and Vulcan (Res., 2222 Main St.), Buffalo, N.Y.

CHRISTENSEN, ORVILLE EDGAR (Jun. '40), Structural Engr., The Austin Co. (Res., 307 East 80th St.), Seattle, Wash.

CLARK, LLOYD HARRISON (Jun. '40), Asst. Engr., State Dept. of Highways, Citizens Bldg., Lima (Res., Alger), Ohio.

CONRADSEN, HAROLD (Jun. '40), 3014 S St., Sacramento, Calif.

COONAN, DANIEL JOSEPH, JR. (Jun. '40), 29 Parkside Drive, Pawtucket, R.I.

COPELAND, JAMES TRACY (Jun. '40), Draftsman, E. I. du Pont de Nemours & Co., Station B, Buffalo (Res., Main St., Clarence), N.Y.

CORNELIUS, QUINCY CORLETT, JR. (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, Box 1311, Tucson, Ariz.

CORTI VIDELA, CARLOS (Assoc. M. '40), Geographical Engr., 10-1284 La Plata, Argentine Republic.

COWDEN, BURNEY BEAUCHAMP (Jun. '40), Care, Bureau of Eng., State Board of Health, Jacksonville, Fla.

TOTAL MEMBERSHIP AS OF JANUARY 9, 1941	
Members	5,672
Associate Members	6,506
Corporate Members	12,178
Honorary Members	35
Juniors	4,443
Affiliates	69
Fellows	1
Total	16,726

COZZENS, JOHN WALTER (Jun. '40), Asst., Corps of Engrs., P.R.R., Fort Wayne, Ind.

CRAMER, JOHN WESLEY (Jun. '40), Detail Draftsman, Vega Airplane Co. (Res., 235 B North Santa Anita Ave.), Burbank, Calif.

DASHE, WILLIAM (Jun. '40), Asst. Project Engr., State Highway Comm., La Porte Office, La Porte, Ind.

DAVENPORT, MELVIN VAIL (Jun. '40), Rodman, C.M.St.P. and P. Ry., Div. Engr. Office (Res., 215 North 9th St.), Miles City, Mont.

DAVIES, JERALD MORRIS (Jun. '40), Asst. Engr., Parker Schram Co., 515 Couch Bldg., Portland (Res., 1101 Jackson St., The Dalles), Ore.

DEGNAN, JAMES SCOTT (Jun. '40), Insp., F. H. McGraw Co., 780 Windsor St., Hartford (Res., 192 Monument St., Groton), Conn.

DEIBLE, HENRY BOWSER (Jun. '40), Eng. Computer, Pittsburgh and Lake Erie R.R., Terminal Bldg., Pittsburgh (Res., 222 Fourth St., Beaver), Pa.

DELANY, AMBROSE GRAHAM (Jun. '40), Production Mgr., Coyne & Delany Co., 828 Kent Ave., Brooklyn, N.Y.

DISKIN, SIMON HYMAN (Jun. '40), Asst. Eng. Draftsman (Mech.), War Dept., Chemical Warfare Service, Bldg. 86, Edgewood Arsenal (Res., 3725 Towanda Ave.), Baltimore, Md.

DOBSON, JOSEPH JACKSON, JR. (Jun. '40), Junior Insp., State Highway Dept., 205 North Greenwood (Res., 1201 Noble), Houston, Tex.

DOODY, JAMES JOSEPH (Jun. '40), Junior Engr., U.S. Engr. Dept., Box 792, Auburn (Res., 305 Twenty-fourth Ave., San Francisco), Calif.

DORAN, JACK KENNEDY (Jun. '40), Box 346, Denison, Tex.

DORE, STEPHEN EDWARD, JR. (Jun. '40), Junior Civ. Eng. Draftsman, Navy Eng. Design, Quonset Point (Res., 206 Montgomery Ave., Edgewood), R.I.

DOWNES, WILLIAM EDWARD, JR. (M. '40), Asst. Engr., Bureau of Eng., City of Chicago, City Hall (Res., 6848 Bennett Ave.), Chicago, Ill.

DOWNEY, ROBERT JOHN (Jun. '40), 2208 Maplewood Ave., Richmond, Va.

DUNN, EMMETT WATERS, JR. (Jun. '40), Instrumentman, E. I. du Pont de Nemours & Co., Charlestown, Md. (Res., 1345 South 4th St., Louisville, Ky.)

DURHAM, CHARLES WILLIAM (Jun. '40), Civ. Engr., Henningson Eng. Co., 730 Service Life Bldg. (Res., 606 South 32d Ave.), Omaha, Nebr.

Duthie, John Milne (Jun. '40), Moronet Hotel, Bakersfield, Calif.

Elgenson, Leonard (Jun. '40), Junior Highway Engr., State Div. of Highways, Centennial Annex (Res., 815 South 5th St.), Springfield, Ill.

Emerson, Cherry Logan (M. '40), Vice-Pres. and Chf. Engr., Robert & Co., Inc., Bona Allen Bldg., Atlanta, Ga.

Fairbank, Allen Norris (Jun. '40), 614 Joliet St., West Chicago, Ill.

Faisant, Joseph Leon (Assoc. M. '40), Associate Engr., Van R. P. Saxe, 100 West Monument St. (Res., 7031 Kenleigh Rd., Stoneleigh), Baltimore, Md.

Fanning, George Stokes (M. '40), Chf. Engr., Erie R.R., 101 Prospect Ave., N.W., Cleveland, Ohio.

Fimlinson, George Theon (Jun. '40), Dist. Engr., SCS, U.S. Dept. of Agriculture (Res., 508 North 4th), Sayre, Okla.

Flynn, Henry Paul (Jun. '40), With Virginia Eng. Co., Inc., Melson Bldg., Newport News (Res., 416 Granby St., Ocean View, Norfolk), Va.

Folmar, James Murphree (Jun. '40), County Engr., Morgan County, Box 154, Decatur, Ala.

Foreman, Chester Alanson (Jun. '40), Junior Surveyor, National Geophysical Co., De Ridder, La.

Frank, John Elden (Assoc. M. '40), Associate Engr. (Civ.), U.S. Engr. Office, Box 1234, Cincinnati, Ohio. (Res., 1 Rosemont Ave., Fort Thomas, Ky.)

Fredrickson, John Henry, Jr. (Assoc. M. '40), Engr., A. Farnell Blair, Carville (Res., Geismar), La.

Fuller, Jack Pearson (Jun. '40), Care, The Panama Canal, General Delivery, Cristobal, Canal Zone.

Ganick, Saul Samuel (Jun. '40), Asst. Engr., U.S. Engr. Office, Park Sq. Bldg., Boston, Mass.

Gantar, Mark Martin (Jun. '40), 1201 Wadsworth, North Chicago, Ill.

Gardner, Werner Clarke (Assoc. M. '40), City Engr., Supt., Water Dept., The Mayor and Council of Salisbury, West Church St. (Res., 503 Smith St.), Salisbury, Md.

Garrelts, Clement Dale (Jun. '40), With Waddell & Hardesty, 101 Park Ave., New York, N.Y.

Gay, William Arthur (Jun. '40), 17618 Detroit Ave., Lakewood, Ohio.

Gerardi, Angelo Peter (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, 226 Post Office Bldg., Jamaica (Res., 1782 Westchester Ave., New York), N.Y.

Gill, John Joseph (Jun. '40), Asst. Estimator and Civ. Engr., Aberthaw Co., 80 Federal St., Boston (Res., 310 Market St., Brighton), Mass.

Goldenberg, Charles Nordhaus (M. '40), 123 East Water St., Santa Fe, N.Mex.

Grady, Walter Thomas (Jun. '40), 4093 Washington St., Roslindale, Mass.

Griffin, Francis Thomas (Jun. '40), 320 East 242d St., New York, N.Y.

Groesbeck, William Francis (Jun. '40), Insp. of Constr., TVA, Eng. Field Office, Cherokee Dam, Jefferson City (Res., 614 Morgan St., Knoxville), Tenn.

Grubb, Clarence Arthur (Jun. '40), Junior Naval Archt., Puget Sound Navy Yard (Res., 265 Burwell St., Apt. 301), Bremerton, Wash.

Guizot, Apollo (Jun. '40), Detail Draftsman, Lockheed Aircraft Corp., Burbank (Res., 701 Palm Drive, Glendale), Calif.

Gullidge, Ellsworth James (Jun. '40), With Boeing Aircraft Co. (Res., 425 Tenth North), Seattle, Wash.

Hall, Forrest Holt (Jun. '40), Foundation Engr., Dames & Moore, 816 West 5th St. (Res., 1201 Maryland St.), Los Angeles, Calif.

Hall, Raymond Francis, Jr. (Jun. '40), With P.R.R. (Res., 311 East Jefferson St.), Fort Wayne, Ind.

Hall, Richard Vernon (Jun. '40), Box 525, Winchester, Tenn.

Hallden, Otto Sebastian (Jun. '40), Asst. San. Engr., State Dept. of Public Health, Dist. Health Unit 9, Mount Sterling, Ill.

Hanover, Joe Grady (Jun. '40), 308 Barton, Hearne, Tex.

Hardgrove, George William (Jun. '40), Trainee, Eng. Dept., Wisconsin Telephone Co., 126 North Superior, Appleton (Res., Eden), Wis.

Hardman, Richard Thornley (Jun. '40), Bridge Designer, State Highway Dept., State House Annex, 5th Floor, Indianapolis, Ind.

Harper, Frank Edwin, Jr. (Jun. '40), Engr., Dravo Corp., Neville Island, Pittsburgh, Pa.

Hecht, Louis Gerard (Jun. '40), Junior Engr., Petracca-Banko, Gunhill Rd. and Baychester Ave. (Res., 945 Sherman Ave.), New York, N.Y.

Henderson, Knox Berry (Jun. '40), Design Engr., National Tank Co., 3100 Sand Springs Rd., Tulsa, Okla.

Henneberger, Wayne (Jun. '40), Research Asst., Univ. of Texas (Res., 1401 Westover Rd.), Austin, Tex.

Hynd, Morrison (Jun. '40), Engr., Midwestern Eng. and Const. Co., 307 Drew Bldg., Tulsa (Res., 1305 Elgin Muskogee), Okla.

Jaco, Leslie Irving (Jun. '40), Junior Insp. of Constr., TVA, Box 452, Jefferson City, Tenn.

Jessen, Dietrich Walter (Jun. '40), Field Engr., Free Port Sulphur Co., Port Sulphur, La.

Johnson, Claud Parham (Jun. '40), Structural Draftsman, Am. Bridge Co. (Res., 325 West 6th), Gary, Ind.

Johnson, Gordon Hervey (Assoc. M. '40), Asst. Engr., U.S. Bureau of Reclamation, 457 Custom House, Denver, Colo.

Johnson, Stanley John (Jun. '40), Engr., Dry Dock Associates, Norfolk Navy Yard (Res., Waterview Apartments, Apt. H-4), Portsmouth, Va.

Jones, Milton Homer, Jr. (Jun. '40), Junior Naval Archt., Puget Sound Navy Yard (Res., 1347 Warren), Bremerton, Wash.

Kaufman, Alvin Daniel (Jun. '40), Route 1, Moundridge, Kans.

Keating, Paul Warren (Jun. '40), Plant Mgr., P. J. Keating Co., Box 124, Chicopee Falls, Mass.

Kelly, James Davidson (Jun. '40), With Lockheed Aircraft Corp., Burbank (Res., 701 Palm Drive, Glendale), Calif.

Kenney, John David, Jr. (Jun. '40), 728 John Jay Hall, Columbia Univ., New York, N.Y.

Kinsella, John Richard (Assoc. M. '40), City Engr., City Bldg. (Res., 814 Monroe St.), Newport, Ky.

Kirven, Jack Broadnax (Assoc. M. '40), City Engr., City of University Park, 3800 University Blvd. (Res., 3009 Milton St.), Dallas, Tex.

Klarer, David (Jun. '40), Asst. Eng. Aide, Maps and Survey Div., TVA, Rockwood, Tenn. (Res., Silver Hills, New Albany, Ind.)

Knox, Charles Eshelby (Assoc. M. '40), Associate Engr., U.S. Geological Survey, 945 Post Office Bldg., Boston, Mass.

Langton, Bernard Bishop (Jun. '40), Care, Monsanto Chemical Co., Everett, Mass.

Leaman, Donald David (Jun. '40), Asst. Engr., Greeley & Hansen, Box 93 (Res., 200 South Polk St.), Tullahoma, Tenn.

Legatski, Leo Max (Assoc. M. '40), Instr. in Civ. Eng., Agri. and Mech. College of Texas, College Station, Tex.

Leichtfuss, Walter Arthur (Jun. '40), 145 North Harwood St., Orange, Calif.

Linsky, Horace (Jun. '40), Civ. Engr., Lynn Constr. Co., Inc., 11 West 42d St., New York (Res., 921 East 31st St., Brooklyn), N.Y.

Lorenz, Joseph George, Jr. (Jun. '40), Structural Engr., Quaker City Iron Works, Tulip St. and Allegheny Ave. (Res., 3110 Fanshawe St., Mayfair), Philadelphia, Pa.

Luchini, Joseph William (Jun. '40), Cost Engr., State Highway Dept., Capitol Bldg., Santa Fe, N.Mex.

Mackey, William Edward (Jun. '40), Teacher, Aeronautics and Physics, St. Rita High School, 6312 South Oakley Ave. (Res., 6951 South Winchester Ave.), Chicago, Ill.

McNeese, Donald Charles (Jun. '40), Junior Engr., U.S. Army Engrs., 700 Central Bldg. (Res., 133 Boren Ave., North), Seattle, Wash.

Magness, William Howard (Jun. '40), 1375 South 3d St., Louisville, Ky.

Mathews, Thomas Alton (Jun. '40), Eng. Aid, Federal Power Comm., 1757 K St., N.W. (Res., 2104 O St., N.W.), Washington, D.C.

May, Edgar Oris (Jun. '40), Eng. Draftsman, Pacific Gas & Elec. Co., 245 Market St., San Francisco (Res., 2908 Regent St., Berkeley), Calif.

Metcalf, Coburn Chapman (Jun. '40), Asst. Engr., State Highway Dept., 1807 Madison Ave. (Res., 1217 Fernwood Ave.), Toledo, Ohio.

Meyer, Norcliffe Sandford, Jr. (Jun. '40), Asst. City Engr., Eng. Dept., Big Spring, Tex.

Miner, Arthur William (Jun. '40), Draftsman, S. P. Co., 65 Market St. (Res., 232 Fourth Ave.), San Francisco, Calif.

Montgomery, Chancellor David (Jun. '40), Asst. Maintenance Engr., Delco Products Div., General Motors Corp., 201 Floral Ave., Dayton, Ohio.

Morgan, Harry S. (Jun. '40), Asst. Engr., Water Works Dept., Cedar Rapids, Iowa.

Moseley, Joe Clifton (Jun. '40), Junior Draftsman, Humble Oil & Refining Co., Baytown (Res., 220 West Pearce, Goose Creek), Tex.

Mowry, Boardman Shaw (Jun. '40), Engr. Draftsman, Link Belt Co., 300 West Pershing Rd. (Res., 2044 West 103d St.), Chicago, Ill.

Murphy, John Joseph (Jun. '40), Architectural Engr., Mortimer J. Murphy, 202 Curtiss Bldg., Buffalo, N.Y.

Nichols, Thomas Alexander, Jr. (Jun. '40), Field Estimator, Austin Co., Naval Air Station (Res., 4527 Eighteenth, N.E.), Seattle, Wash.

Nilmeier, Herbert Phillip (Jun. '40), Teaching Asst., Univ. of California (Res., 1799 Euclid Ave., Apt. 6), Berkeley, Calif.

Norse, John Hronvecz (Assoc. M. '40), Layout Draftsman, Consolidated Aircraft, San Diego (Res., 7720 Herschel Ave., La Jolla), Calif.

O'Brien, John Thomas (Jun. '40), Asst. Hydr. Engr., SCS, U.S. Dept. of Agriculture, Box 26, Waco, Tex.

Orton, Donald Whitney (Jun. '40), Engr., Tennessee Copper Co., Copperhill, Tenn.

Owens, Edwin Watts (Jun. '40), Care, Southern Materials Corp., Box 34, Richmond, Va.

Paxson, Lyle Laren (Jun. '40), Asst. Engr., State Highway Comm. (Res., 1034 Tyler), Topeka, Kans.

Porter, Howard Eugene (Jun. '40), Asst. State Supervisor, State Mineral Surveys, National Defense Project, WPA, 426½ Broad, Rome, Ga.

Pyle, Ira Lawrence (M. '40), Chf. Engr., C. & O. Ry., 825 East Main St., Richmond, Va.

Pyzynski, Arthur John (Jun. '40), Estimator, Young Radiator Co., Racine (Res., 2214 South 7th St., Milwaukee), Wis.

Redmond, John, Jr. (Jun. '40), County Sanitation Officer, Butler County Health Dept., Box 359, Greenville, Ala.

Reinicer, Louis Gerard (Jun. '40), With the Thompson Lichtner Co., Inc., 620 Newbury St., Boston (Res., 47 Denver St., Saugus), Mass.

Riffe, Norman Terry (Jun. '40), Asst. Engr., East Bay Sewage Disposal Survey, City Hall, Berkeley, Calif.

Ritter, Leo John, Jr. (Jun. '40), Instr., Civ. Eng., Mississippi State College, State College, Miss.

Roberts, Clyde Jefferson (Jun. '40), With State Road Dept., 120 Mabbette St., Kissimmee, Fla.

Robin, Sidney (Jun. '40), 4745 North 12th St., Philadelphia, Pa.

Sandlin, Patrick Herman, Jr. (Jun. '40), County Engr., Lawrence County, Box 216, Moulton, Ala.

Santry, Israel Wootan, Jr. (Jun. '40), Draftsman, California Water Service Co., 347 West Santa Clara (Res., 816 South 11th), San Jose, Calif.

Schilling, Karl Browne (M. '40), Maj. Corps of Engrs., U.S. Army, 900 Custom House, Philadelphia, Pa.

Schultz, Donald Parker (Jun. '40), Structural Draftsman, Am. Bridge Co. (Res., 405 Bridge St.), Gary, Ind.

Schultz, Niels Jorgen, Jr. (Jun. '40), 430 Hazel Ave., Millbrae, Calif.

Segal, Nathan (Jun. '40), 2014 Seventy-first St., Brooklyn, N.Y.

Shapiro, Irving (Jun. '40), Draftsman, Designer, and Detailer, Merritt, Chapman & Scott Corp., New York, N.Y. (Res., 2542 South Darien St., Philadelphia, Pa.)

Sharp, Thomas Fredrick, Jr. (Jun. '40), Grading Foreman, R. E. McKee Constr. Co., Camp Bowie, Brownwood (Res., 3702 Holland, Dallas), Tex.

SLICER, WILLIAM ALEXANDER (Jun. '40), Structural Engr., Hudson Supply & Equipment Co., Rosslyn, Va. (Res., Gaithersburg, Md.)

SMITH, EDGAR FIELD (Jun. '40), Southold, N.Y.

SMITH, EDWARD GERALD (Jun. '40), Junior Engr., War Dept., U.S. Engrs., Denison, Tex.

STAUBLE, JOHN HENRY (Assoc. M. '40), Asst. Engr., Eng. Dept., Port-of-Spain City Council, Port of Spain (Res., 14 Hillside Ave., Cascade), Trinidad, B.W.I.

STINCHFIELD, WILLIAM EMERSON (Jun. '40), Examiner, U.S. Civ. Service Comm., 450 Federal Office Bldg., Seattle, Wash.

SYMANCYK, CLIFFORD ERNEST (Jun. '40), Civ. Engr., Raymond Concrete Pile Co., 140 Cedar St., New York, N.Y.

SYMONS, GEORGE EDGAR (Assoc. M. '40), Chf. Chemist, Buffalo Sewer Authority, Bird Island Laboratory, Buffalo, N.Y.

TAFT, ELMER LOUIE (Jun. '40), Eng. Technical Foreman, Grazing Service, Dept. of Interior, Camp Chilly, G-111, Mackay, Idaho.

TEDESKO, ANTON (M. '40), Mgr., Structural Dept., Roberts & Schaefer Co., 307 North Michigan Ave., Chicago, Ill.

TORZYNSKI, THADEUS THEODORE (Jun. '40), Draftsman, A1, Bridge Design Office, State Highway Dept., Room 746 State Bldg. (Res., 502 West Allegan St.), Lansing, Mich.

VROMAN, GEORGE MILES (Jun. '40), 430 East Foster Ave., State College, Pa.

WALKER, JOHN VANIE (Jun. '40), Junior Engr., U.S. Bureau of Reclamation, Klamath Falls, Ore.

WARDWELL, FRANK PEIRSOL (Jun. '40), Rate Technician, New England Power Assn., 441 Stuart St. (Res., 400 Marlborough St., Apt. 8), Boston, Mass.

WEBERLING, RICHARD ROBERT (Jun. '40), Junior Constr. Engr., M. W. Kellogg Co., Box 2311, Baton Rouge, La.

WEINSTEIN, JESSE (Jun. '40), Draftsman, Alfred Kastner, 2 Dupont Circle (Res., 4120 Fourteenth St., N.W.), Washington, D.C.

WHIPPLE, WILLIAM, JR. (Assoc. M. '40), Capt., Corps of Engrs., U.S. Army, Fort Belvoir, Va.

WHITE, ROSSITER LAWRENCE (Jun. '40), Junior Engr. (Civ.), War Dept., Channel Design Section, U.S. Engrs. Office, 8th and Figueroa Sts. (Res., 1715 Echo Park Ave.), Los Angeles, Calif.

WILLE, RICHARD MERWIN (Jun. '40), With Inland Lime & Stone Co., Monistique (Res., 67 Thorpe St., Pontiac), Mich.

WING, DAVID WONGCHUNG (Jun. '40), Junior Eng. Aide, State Div. of Highways, 604 Plaza Bldg. (Res., 1613 Sixth St.), Sacramento, Calif.

WITHERELL, PAUL WALKER (Jun. '40), Civ. Engr., The Austin Constr. Co., 19 Rector St., New York, N.Y. (Res., 3 Bradford St., Taunton, Mass.)

WRIGHT, CHANER LEON (Assoc. M. '40), Associate Engr., Gen. Constr., Div. of Architecture, State Dept. of Public Works, Box 341, Veterans Home, Calif.

YARNALL, WAYNE BROWN (Jun. '40), Civ. Engr., Eng. Dept., Duquesne Works, Carnegie Illinois Steel Corp., Duquesne (Res., 3016 Jenny Lind St., McKeesport), Pa.

ZIPF, WILLIAM PETER (Jun. '40), Junior Engr., Petracca & Banko, Inc., 69-19 Queens Blvd., Winfield (Res., 7-03 One hundred and forty-ninth St., Whitestone), N.Y.

ZUKOWSKI, VENCESLAUS JOSEPH (Assoc. M. '40), Structural Engr., Greeley & Hansen, 6 North Michigan Ave. (Res., 2210 Walton St.), Chicago, Ill.

MEMBERSHIP TRANSFERS

ALLNER, FREDERICK ABELS (Assoc. M. '14; M. '40), Pres., Safe Harbor Water Power Corp., 1605 Lexington Bldg., Baltimore, Md.

BAILEY, SAMUEL MAJOR (Assoc. M. '37; M. '40), Prin. Engr., Chf., Flood Control Div., U.S. Engr. Dept., Box 59, Louisville, Ky.

BRANDTZAEG, ANTON (Assoc. M. '26; M. '40), Mgr., Pres., A/S Anlegg, Sondre gate 7, Trondheim, Norway.

BROOKS, ROBERT BLEMKER, JR. (Jun. '34; Assoc. M. '40), Asst. Engr., Robert B. Brooks, 1510 Mart Bldg. (Res., 511 Purdue Ave., University City), St. Louis, Mo.

BUCHANAN, SPENCER JENNINGS (Jun. '26; Assoc. M. '36; M. '40), Engr., Mississippi River Comm., Box 80 (Res., 3022 Cherry St.), Vicksburg, Miss.

CAPWELL, CARL WAYLAND (Jun. '30; Assoc. M. '40), Insp., San Diego Consolidated Gas & Elec. Co., 6th and E Sts., San Diego (Res., 255 Sea Vale St., Chula Vista), Calif.

CARLSON, HARRY (Jun. '38; Assoc. M. '40), Associate Engr., U.S. Engr. Office, 615 Commerce Bldg. (Res., 2109 Wellesley Ave.), St. Paul, Minn.

COLE, EDWARD SHAW (Jun. '33; Assoc. M. '40), Engr., The Pitometer Co., 50 Church St., New York, N.Y.

CRAWFORD, LEONARD KENNETH (Jun. '37; Assoc. M. '40), Care, Capital Eng. Co., 322½ South 6th St., Springfield, Ill.

DAVIS, FRANCIS MARION (Jun. '28; Assoc. M. '32; M. '40), Asst. Dist. Engr., State Highway Dept., Paris, Tex.

GOWDY, JOSEPH SCOTT (Jun. '31; Assoc. M. '40), Sales Engrs., Wyatt Metal & Boiler Works (Res., 1725 Wroxton Court), Houston, Tex.

HART, FRANCIS COYNE (Jun. '30; Assoc. M. '40), Asst. Hydr. Engr., Dept. of Interior, U.S. Bureau of Reclamation, Custom House (Res., 2229 Holly St.), Denver, Colo.

HEFELFINGER, CHARLES MOSES (Jun. '35; Assoc. M. '40), Contr., 641 Ocean Ave., Lakewood, N.J.

HICKOX, GEORGE HAROLD (Jun. '26; Assoc. M. '35; M. '40), Senior Hydr. Engr., TVA, Hydraulic Laboratory, Norris, Tenn.

JACKSON, SHERMAN KEITH (Jun. '31; Assoc. M. '40), Associate Hydr. Engr., U.S. Geological Survey, Post Office Bldg., Fort Smith, Ark.

JEWETT, GEORGE EDWARD (Jun. '34; Assoc. M. '40), Lt. (jg), U.S. Navy; Cont. Engr., Chicago Bridge & Iron Co., 165 Broadway, New York, N.Y.

JOHNSON, ARTHUR DELAFIELD (Jun. '35; Assoc. M. '40), Care, William T. Johnson, 3255 Front St., San Diego, Calif.

MINER, CHARLES JOHN (Jun. '29; Assoc. M. '40), Engr., Clinton Constr. Co., 923 Folsom St. (Res., 1454 Thirty-fourth Ave.), San Francisco, Calif.

NOLEN, JERRY AFTEN (Jun. '36; Assoc. M. '40), 1st Lt., U.S. Army, Ordnance Dept., Reserve, Aberdeen Proving Ground, Md.

PAYNE, EUGENE BENNETT (Jun. '31; Assoc. M. '40), Div. Engr., Shell Oil Co., Inc., 2014 Tulare St. (Res., 1301 Adoline St.), Fresno, Calif.

ROMINIECKI, ANDREW JOSEPH (Jun. '31; Assoc. M. '40), Chf. Draftsman, Sales Const. Dept., Sun Oil Co., 1608 Walnut St. (Res., 3163 Richmond St.), Philadelphia, Pa.

SCHAEFER, RUDOLPH FERDINAND (Assoc. M. '27; M. '40), Chf. Engr., Wilberding & Palmer, Inc., Staples-Pake Bldg. (Res., 210 Summerville Court), Mobile, Ala.

SMALL, ROLAND ROBERT (Jun. '34; Assoc. M. '40), Engr., P. T. Cox Constr. Co., Inc., 270 Broadway, New York (Res., 192 East 8th St., Brooklyn), N.Y.

SPANGLER, MERLIN GRANT (Assoc. M. '27; M. '40), Research Associate Prof., Civ. Eng., Iowa Eng. Experiment Station, Iowa State College, Ames, Iowa.

SPENCER, CHARLES BRENNARD (Jun. '31; Assoc. M. '40), Engr., William T. Nolan, 710 Queen and Crescent Bldg. (Res., 5435 Coliseum St.), New Orleans, La.

VINCENT, GEORGE SYLVESTER (Jun. '22; Assoc. M. '40), Highway Bridge Engr., Public Roads Administration, 502 U.S. Court House, Fort Worth, Tex.

REINSTATEMENTS

CUMMINS, CHARLES ALBERT, Assoc. M., reinstated Jan. 2, 1941.

DEMOREST, GEORGE MYRON, Assoc. M., reinstated Jan. 2, 1941.

FINNELL, WOOLSEY, M., reinstated Dec. 18, 1940.

GIANNOTTI, ALFRED, Jun., reinstated Jan. 2, 1941.

GUIAZDO, JOSE RAMON, Assoc. M., reinstated Dec. 31, 1940.

KRUGER, HERMAN AUGUST, M., reinstated Jan. 2, 1941.

MARKL, ARTHUR RICHARD CORBINIAN, Assoc. M., reinstated Jan. 2, 1941.

MILINOWSKI, ARTHUR SIEGFRIED, M., reinstated Dec. 9, 1940.

MURRAY, ANGUS NORMAN, Jun., reinstated Jan. 2, 1941.

PAPPIN, GORDON FRANCIS, Jun., reinstated Jan. 2, 1941.

PEASE, JAMES NORMAN, M., reinstated Jan. 9, 1941.

PUTNAM, CHARLES EDGAR, M., reinstated Jan. 6, 1941.

RANDOLPH, JAY, M., reinstated Jan. 2, 1941.

SCHAMBERGER, SANFORD OATMAN, Assoc. M., reinstated Jan. 7, 1941.

TAPPAN, KIRBY HEWITT, Assoc. M., reinstated Jan. 2, 1941.

TAYLOR, WYLLYS HARD, M., reinstated Jan. 2, 1941.

TROST, ADOLPHUS GUSTAVUS, M., reinstated Jan. 6, 1941.

WHITAKER, RALPH WARREN, Assoc. M., reinstated Jan. 2., 1941.

RESIGNATIONS

ANDREWS, CHARLES MORRISON, Assoc. M., resigned Dec. 31, 1940.

BABBITT, BENJAMIN TALBOT, Jun., resigned Dec. 31, 1940.

BAKER, GEORGE FARNSWORTH, Assoc. M., resigned Dec. 31, 1940.

BELL, HAROLD BRADFORD, Jun., resigned Dec. 31, 1940.

BRYANT, CHARLES BYRN, M., resigned Dec. 31, 1940.

BURDETT, OWEN LONG, Assoc. M., resigned Dec. 31, 1940.

BURKO, WILLIAM, Jun., resigned Dec. 31, 1940.

BURNETT, BRUCE BURT, Assoc. M., resigned Dec. 31, 1940.

BURY, CHARLES LINCOLN, Jun., resigned Dec. 31, 1940.

BROOM, THOMAS GREEN, Assoc. M., resigned Dec. 31, 1940.

DAY, GORDON, Jun., resigned Dec. 31, 1940.

DEFREES, RAYMOND GARFIELD, Assoc. M., resigned Dec. 31, 1940.

DUFFY, JAMES MERRITT, Assoc. M., resigned Dec. 31, 1940.

FLECK, KENNETH JAMES, Jun., resigned Dec. 31, 1940.

FORMAN, FRED PATON, Jun., resigned Dec. 31, 1940.

GAUL, JOHN WILCOX, Jun., resigned Dec. 31, 1940.

GENDRON, ROLAND ARTHUR, Jun., resigned Dec. 31, 1940.

GETTY, GEORGE CLINTON, Jun., resigned Dec. 31, 1940.

GIBSON, COUNT DILLON, M., resigned Dec. 31, 1940.

GIBSON, THOMAS FENNER, M., resigned Dec. 31, 1940.

GLENZ, FREDERICK GEORGE, JR., Jun., resigned Dec. 31, 1940.

GOODHART, MORRIS, Jun., resigned Dec. 31, 1940.

GUINOTTE, JOHN, Assoc. M., resigned Dec. 31, 1940.

HARDY, FRANCIS HATHAWAY, M., resigned Dec. 31, 1940.

HASSAN, ACHESON FLYNN, M., resigned Dec. 31, 1940.

HESTER, ELMER WEBB, Assoc. M., resigned Dec. 31, 1940.

HOYT, KENDALL KING, Assoc. M., resigned Dec. 31, 1940.

JOBLIN, JOHN GRANT, Jun., resigned Dec. 31, 1940.

KARNOPP, EDWIN BENJAMIN, Assoc. M., resigned Dec. 31, 1940.

KIBBE, LESLIE ARTHUR, M., resigned Dec. 31, 1940.

KINCAID, MURTLAND, M., resigned Dec. 31, 1940.

KRONE, ARNOLD HENRY, M., resigned Dec. 31, 1940.

LAWRENCE, EGBERT VANHORN, Assoc. M., resigned Dec. 31, 1940.

LORENZ, GILBERT GUSTAV, Jun., resigned Dec. 31, 1940.

LYONS, PERCY FELIX, Assoc. M., resigned Dec. 31, 1940.

MAHONEY, ROBERT MATTHEWS, Jun., resigned Dec. 31, 1940.

MICHAEL, WILLIAM WHIPPLE, M., resigned Dec. 31, 1940.

MILHOLLIN, AUSTIN BARLOW, Jun., resigned Jan. 8, 1941.

OKELL, OTTA CLARENCE, Assoc., M., resigned Dec. 31, 1940.

PACCAGNELLA, CHARLES PAUL, Jun., resigned Dec. 31, 1940.

PARKER, WILLIAM EDWARD, M., resigned Dec. 31, 1940.

PHIMISTER, ALBERT, Assoc. M., resigned Dec. 31, 1940.

RIST, HAROLD WILLIAM, Jun., resigned Dec. 31, 1940.

RUSSELL, FRANK MCKLVEEN, Jun., resigned Dec. 31, 1940.

SCHWERIN, BENJAMIN, M., resigned Dec. 31, 1940.

SHLESSINGER, JACOB, Assoc. M., resigned Dec. 31, 1940.

SLOCUM, STEPHEN ELMER, M., resigned Dec. 31, 1940.

SNELL, RUTHERFORD, Assoc. M., resigned Dec. 31, 1940.

STONE, THERON BURNHAM, Jun., resigned Dec. 31, 1940.

STORY, JOHN WILSON, Assoc. M., resigned Dec. 31, 1940.

STURTEVANT, MERRILL HOUSTON, Assoc. M., resigned Dec. 31, 1940.

SWIFT, ANGUS VAN AUSDOL, Assoc. M., resigned Jan. 8, 1941.

TOUSEY, BERTLAND JAY GRANDISON, Jun., resigned Dec. 31, 1940.

TOWERS, RICHARD RUTFRED, Jun., resigned Dec. 31, 1940.

TRAINOR, LEE SMITH, Assoc. M., resigned Dec. 31, 1940.

TROOK, MARK MONROE, Jun., resigned Dec. 31, 1940.

TROTTER, HAROLD LYNDRIDGE, M., resigned Dec. 31, 1940.

TRUSCOTT, GEORGE BATE EDMUND, Assoc. M., resigned Dec. 31, 1940.

VAN ZANDT, H., Assoc. M., resigned Dec. 31, 1940.

VAN CAMP, CHANNING POLLOCK, Jun., resigned Dec. 31, 1940.

VORONZOFF, PAUL ILEECH, Assoc. M., resigned Dec. 31, 1940.

WALKER, NORVELL MCVEIGH, Jun., resigned Dec. 31, 1940.

WEINKAUFF, HENRY CHRISTIAN CORNELIUS, Jun., resigned Dec. 31, 1940.

WHITTIER, WILMOT EDGAR, M., resigned Dec. 31, 1940.

WILKINSON, READ ARTHUR, Jun., resigned Dec. 31, 1940.

WRIGHT, EARL SEAWARD, Assoc. M., resigned Dec. 31, 1940.

YASINES, STAN FRANZ, Assoc. M., resigned Dec. 31, 1940.

YEE, JEWETT CHU YICK, Jun., resigned Dec. 31, 1940.

YOUNG, CHARLES ASA DILTS, M., resigned Dec. 31, 1940.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

February 1, 1941 NUMBER 2

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

ALLEN, EDWARD RUSSELL (Assoc. M.), Towson, Md. (Age 35) (Claims RCA 2.2 RCM 8.8) July 1926 to date with J. E. Greiner Co., Baltimore, Md., as Asst. Res. Engr., Draftsman, Asst. Chf. Draftsman, Res. Engr., Chf. Draftsman, Project Engr., and (since Oct. 1940) Archt.-Engr. Representative.

ANDERSON, DANIEL FRENCH, Vinita, Okla. (Age 37) (Claims RC 10.1 D 5.8) Jan. 1936 to date Asst. Res. Engr. Inspector, Res. Engr. Inspector, and Associate Engr., PWA; previously County Engr., Rogers County, Okla.

BROWN, JAMES WESLEY (Assoc. M.), McComb, Miss. (Age 38) (Claims RCA 1.2 RCM 6.1) Jan. 1935 to date City Engr., McComb, Miss., and in private practice.

CLARKE, SAMUEL MONTAGUE, Chicago, Ill. (Age 36) (Claims RCA 3.0 RCM 6.0) July 1926 to date with Greeley & Hansen in various capacities, since Aug. 1940 partner in firm.

COX, GLEN NELSON (Assoc. M.), University, La. (Age 37) (Claims RCM 11.4) Sept. 1929 to date with Louisiana State Univ., as Associate Prof., Depts. of Civ. Eng. and Eng. Mechanics, and (since July 1936) Prof. of Mechanics and Hydraulics, Dept. of Eng. Mechanics.

DE JONG, TIM, Astoria, Ore. (Age 37) (Claims RCA 2.7 RCM 5.7) Aug. 1935 to date in private practice, also County Surveyor, Clatsop County.

DLYN, HARRY LOUIS, New York City. (Age 49) (Claims RCA 3.8 RCM 20.2) Jan. 1924 to date Chf. Engr., Chanin Constr. Co., Inc.

GALINDO-QUIROGA, EUDORO, Cochabamba, Bolivia. (Age 39) (Claims RC 10.0) 1937 to date Constr. Engr. in cooperaton with Companiai Constructora Cochabamba, and (since 1939) on contract with Govt.; previously Chf. Engr. for Govt. of Receiving Comm., and Administrator of Potosi-Sucre R. R.

HALL, FRANCIS EVERETT, Greenville, Miss. (Age 36) (Claims RCA 2.0 RCM 11.0) Jan. 1928 to date Chf. Engr. and Supt., Sewer and Water Dept.

HARKNESS, FRANK BRACE (Assoc. M.), Louisville, Ky. (Age 37) (Claims RCA 10.3 RCM 5.2) Oct. 1926 to date with U.S. Engr. Office, as Jun. Engr., Asst. Engr., Associate Engr., Engr., and (since March 1936) Senior Engr. (Civil).

HILL, KENNETH VINTON, Chicago, Ill. (Age 41) (Claims RCA 8.0 RCM 10.3) Oct. 1922 to date with Greeley & Hansen, Hydr. and San. Engrs., as Asst. Engr., and since Aug. 1940 partner in firm.

IRELAND, CARROL BERT, National City, Calif. (Age 57) (Claims RCA 3.9 RCM 16.9) March 1919 to Aug. 1932 and Sept. 1937 to date City Engr., National City; in the interim Road Foreman and Guard, San Diego County Ind. Road Camp, and CWA Engr.

LAMBRECHT, RICHARD WALDO (Assoc. M.), Detroit, Mich. (Age 41) (Claims RCA 1.9 RCM 13.8) Jan. 1934 to date Vice-Pres., O. W. Burke Co.

LANGDON, PAUL EUGENE, Chicago, Ill. (Age 41) (Claims RCM 14.0) July 1920 to date Instrumentman, Inspector, and Draftsman with Greeley & Hansen, Hydr. and San. Engrs.; since Aug. 1940 partner in firm.

MCCLURG, VERNE ORVA, Chicago, Ill. (Age 50) (Claims RCA 7.0 RCM 17.0) 1928 to date Chf. Structural Engr., Holabird & Root, Archts., being Head of Structural Dept.

MARTIN, PARK HUSSEY, Bellevue, Pa. (Age 53) (Claims RC 17.3 D 13.6) Jan. 1935 to date Chf. Engr., Allegheny County Planning Comm.

OVERSHINER, WILLIAM HUMPHREYS (Assoc. M.), San Pedro, Calif. (Age 47) (Claims RCA 13.5 RCM 7.7) June 1940 to date Lt. Comdr. CEC, U.S. Naval Reserves; previously Field and Office Engr., U.S. Engr. Dept.; Asst. Engr., Orange County Flood Control Dist., Santa Ana, Calif.

OWENS, WILLIAM EVAN, Worthington, Ohio (Age 43) (Claims RCA 4.0 RCM 9.5) 1929 to date Asst. Chf. Engr. and Chf. Engr., Div. of Conservation and Natural Resources, State of Ohio.

SANGER, FREDERICK JAMES (Assoc. M.), Shanghai, China. (Age 35) (Claims RCA 6.0 RCM 6.0) Aug. 1934 to date Head of Dept. of Eng. and Bldg., Henry Lester Inst.

SPOFFORD, JAMES, Boise, Idaho. (Age 56) (Claims RCA 12.3 RCM 9.0) Jan. 1939 to date Commr. of Reclamation (State Engr.), State of Idaho; previously with Mountain Home (Idaho) Irrigation Dist. as Secy.-Mgr. of Mountain Home Irrigation Dist.

STEWART, CHARLES G., Pittsburgh, Pa. (Age 55) (Claims RCA 4.6 RCM 23.6) Jan. 1917 to date with The Pittsburgh & Lake Erie R.R. as Eng. Draftsman and (since Dec. 1940) Asst. Chf. Engr.

TSCHUDY, LIONEL CARL (Assoc. M.), Amarillo, Tex. (Age 42) (Claims RC 9.9 D 3.6) April 1935 to date with SCS, U.S. Dept. of Agriculture, as Superv. Engr., Chf. Engr., Regional Engr., Constr. Engr., and (since July 1939) Asst. Regional Engr.

WACHRAMEEFF, ARTEMY, Boston, Mass. (Age 40) (Claims RCA 7.2 RCM 7.1) Jan. 1937 to

date Designer, Stone & Webster Eng. Corporation; previously associated with and later successor to Paul Francais, Registered Cons. Engr., French Morocco.

APPLYING FOR ASSOCIATE MEMBER

ARCHIBALD, GEORGE EDWARD, Los Angeles, Calif. (Age 47) (Claims RCA 10.6) May 1940 to date Field Engr., So. California Edison Co.; Nov. 1931 to March 1940 with Metropolitan Water Dist. of So. California.

BENSON, BEN, San Antonio, Tex. (Age 29) (Claims RC 3.2 D 2.9) Aug. 1935 to May 1936 and Feb. 1937 to date with WPA, as Senior Estimator, Project Supt., Supervising Engr., and (since Sept. 1940) Jun. Engr.; in the interim with Frank Parrott, Gen. Contr.

BLICKENSDERFER, ALFRED (Junior), Knoxville, Tenn. (Age 32) (Claims RCA 3.1) Sept. 1935 to date with Hydraulic Data Div., TVA, as Eng. Aide, Jun. Hydr. Engr., and (since July 1939) Asst. Hydr. Engr.

CAMPBELL, PAUL FREDERICK, Pittsburgh, Pa. (Age 39) (Claims RCA 10.6) Nov. 1940 to date Designer, Rust Eng. Co., Pittsburgh, Pa.; previously Designer, successively with Dravo Corporation and E. I. du Pont de Nemours & Co., Wilmington, Del., and other companies.

CARY, ALLEN STUART, Seattle, Wash. (Age 36) (Claims RCA 1.8) Jan. 1937 to date with U.S. Engr. Dept., as Inspector, and (since June 1939) also Jun. Geologist; previously graduate student.

ERNEST, RALPH NELSON (Junior), Coco Solo, Canal Zone. (Age 32) (Claims RCA 5.0 RCM 1.6) June 1931 to date with U.S. Navy, as Lieut. (C.E.C.); since June 1939 Public Works Officer, Submarine Base, Coco Solo, Canal Zone.

EVANS, THOMAS CHARLTON, Charleston, S.C. (Age 30) (Claims RCA 2.1 RCM 3.2) Sept. 1938 to date Asst. Civ. Engr., South Carolina Public Service Authority; previously Structural Draftsman, Robert and Co., Engrs. and Archts.; Civ. Engr., Callaway Mills, LaGrange, Ga.

FOSTER, HERBERT BISMARCK, JR. (Junior), Berkeley, Calif. (Age 32) (Claims RCA 8.9) Feb. 1935 to date with Bureau of San. Eng., State Dept. of Public Health, as Jun. San. Engr., and (since Oct. 1938) Asst. San. Engr.

GRANT, FRANCIS RALPH, El Dorado, Ark. (Age 31) (Claims RCM 7.0) Sept. 1937 to date with Lion Oil Refining Co. as Asphalt Research Engr., and (since Nov. 1939) Director of Research; previously with Berry Asphalt Co., Chicago, Ill.

GREENLEAF, JOHN WHITTIER, JR. (Junior), Westwood, Mass. (Age 32) (Claims RCA 2.6 RCM 4.4) Oct. 1940 to date with Charles T. Main, Inc., on design of water and sewerage, Camp Edwards, Falmouth, Mass.; previously with Metcalf & Eddy, and Bayard F. Snow and X. Henry Goodnough, Inc., Boston, Mass.

GRIFFITH, JOSEPH GORDON (Junior), Diablo Hts., C.Z. (Age 32) (Claims RCA 5.3 RCM 2.0) Sept. 1940 to date Asst. Engr. (Dept. Engr.), U.S. Engrs.; previously Jun. Engr., The Panama Canal; Bridge Designer, Vermont Dept. of Highways; Jun. Foreman of construction and maintenance, U.S. Forest Service.

GUNN, DONALD, Baltimore, Md. (Age 38) (Claims RCA 2.1 RCM 12.8) 1930 to date with Pennsylvania Water & Power Co., and Safe Harbor Water Power Corporation, assisting Chf. Engr., during past three years as Asst. to Chf. Engr.

HAFTERSON, HAROLD DONALD (Junior), Denver, Colo. (Age 32) (Claims RCA 2.6) Oct. 1938 to date with Bureau of Reclamation, as Instrumentman, Jun. Engr., and (since Dec. 1939) Asst. Engr.; previously with U.S. Forest Service and Idaho State Dept. of Highways.

HENSON, EDGAR LAWRENCE, Decatur, Ala. (Age 48) (Claims RCA 13.5 RCM 8.4) July 1933 to date with Alabama Highway Dept., as Plans Designer, Transitman, Res. Engr. (Project), Res. Engr. (Dist.), Project Engr., and (since July 1940) Div. Materials Engr.

HOLLICK, ROBERT EBENEZER (Junior), Ancon, Canal Zone. (Age 32) (Claims RCA 1.6) June 1939 to date Asst. to Associate Structural Engr., Special Eng. Div., The Panama Canal, Diablo Heights, C.Z.; previously Asst. Eng. Draftsman to Asst. Office Engr., Design Dept., TVA, Knoxville, Tenn.

LORENZ, MERRILL CHARLES (Junior), Rock Island, Ill. (Age 32) (Claims RCA 7.0 RCM 0.7) April 1934 to date with U.S. Engr. Office as Concrete Technician, Asst. Engr., Engr. in Chg., Asst., Asst. Res. Engr., Engr., and (since Aug. 1940) Res. Engr.

MILES, THOMAS KIRK (Junior), Berkeley, Calif. (Age 30) (Claims RCA 3.2) March 1939 to date Research Engr., Shell Development Co., Emeryville, Calif.; previously Asst. Soil Technician, TVA, Knoxville, Tenn.

RAMSEY, PHILIP BRUCE (Junior), Pittsburgh, Pa. (Age 32) (Claims RCA 4.5) June 1937 to date Structural Engr., Structural Dept., Aluminum Co. of America; previously Asst. Structural Engr., TVA; with South Dakota Highway Comm.

RUDDY, JOHN WILLIAM (Junior), Vicksburg, Miss. (Age 32) (Claims RCA 2.0 RCM 0.5) Nov. 1940 to date Civ. Eng. Draftsman, War Dept., U.S. Engr. Office; previously with WPA, Sitek Eng. Co., and Pennsylvania State Dept. of Highways.

RUGGE, GEORGE, Chicago, Ill. (Age 28) (Claims RCA 1.1) July 1935 to date with Atchison, Topeka and Santa Fe Ry., as Chainman, Rodman, Transitman, and (since April 1940) Asst. Engr.

SAMUEL, MYER (Junior), Sacramento, Calif. (Age 32) (Claims RCA 6.6) Aug. 1931 to date with U.S. Engr. Office as Jun. Civ. Engr., and (since July 1935) Associate Civ. Engr.

SCHOTT, EUGENE ALBERT (Junior), Cleveland, Ohio. (Age 32) (Claims RCA 4.0) Sept. 1939 to date graduate student and Asst. (award by Pres. of school), Case School of Applied Science; previously with Tuscarawas County Engr. and Commrs., U.S. Govt., and Ohio State Highway Dept.

SCHULCZ, JOSEPH ANDREW (Junior), Upper Darby, Pa. (Age 32) (Claims RCA 4.9 RCM 2.1) June 1937 to Sept. 1940 and Dec. 1940 to date Structural Designer with W. Herbert Gibson, Cons. Engr., Philadelphia, Pa.; in the interim Structural Designer with Irving S. Towsley, Cons. Engr.; previously Inspector and Jun. Engr., U.S. Engr. Office, Philadelphia.

SESSUMS, ROY THOMAS (Junior), Ruston, La. (Age 32) (Claims RCA 1.0) Sept. 1937 to date with Louisiana Polytechnic Inst. as Instructor in, and Asst. Prof. of, Civ. Eng., and (since Aug. 1940) Dean of School of Eng.; since 1937 also Consultant, Designer, Expert-Witness, etc.

SPILIOOJ, GODFREY DESIDERIUS, Stewart Manor, N.Y. (Age 44) (Claims RCA 10.8) Aug. 1934 to May 1938 and Nov. 1939 to Sept. 1940, and Jan. 1941 to date, Designer, successively with American Gas & Elec. Service Corporation, Foster Wheeler Corporation, and (at present) F. R. Harris, Cons. Engrs., all of New York City.

SLATER, HAROLD HERBERT (Junior), Wooster, Ohio. (Age 32) (Claims RCA 4.2) March 1933 to date Asst. Engr., Wayne County Engr.'s Office.

SMITH, CARNEAL KIRBY (Junior), Balboa, Canal Zone. (Age 32) (Claims RCA 1.7) Sept. 1939 to date with The Panama Canal as Asst. Soil Technician and (since Nov. 1940) Associate Civ. Engr.; previously with TVA as Asst. Eng. Aide, Eng. Aide, Jun. Hydr. Engr., Jun. Civ. Engr., and Asst. Materials Engr.

SPENCER, ARTHUR CLIFTON, Baltimore, Md. (Age 47) (Claims RCA 24.7) April 1917 to date with Consolidated Gas, Elec. Light & Power Co., as Inspector, Chf. Inspector, Asst. Supt., and (since Sept. 1922) Supt., in responsible charge of Bldg. Constr. Dept.

STONE, COURTNEY LEO (Junior), Pittsburgh, Pa. (Age 32) (Claims RCA 4.6) March 1937 to date with Pittsburgh-Des Moines Steel Co., on experimental and research design, etc.; previously with Harbison-Walker Refractories.

TOWNSEND, GEORGE ELLSWORTH (Junior), Fountain City, Tenn. (Age 28) (Claims RCA 2.0) Aug. 1935 to date with TVA, Flood Sec., as Asst. Eng. Draftsman, Asst. Eng. Aide, Eng. Aide, Jun. Hydr. Engr., and (since Jan. 1940) Asst. Hydr. Engr.

TRACY, JOHN WILLIAM MERLE, Westfield, Ind. (Age 40) (Claims RCA 10.1) Oct. 1938–Oct. 1939 Jun. Engr., and Nov. 1939 to date Asst. Engr., Federal Power Comm., Washington, D.C.; previously Senior Engr. and Inspector-Foreman, Dept. of Agriculture, Bureau of Public Roads, Washington, D.C.

URBAN, WILLIAM JOHN, Lake Geneva, Wis. (Age 31) (Claims RCA 2.5 RCM 4.1) June 1938 to date Engr., Consoer, Townsend & Quinlan, Cons. Engrs., Chicago, Ill.; previously in private practice as Cons. Engr., Milwaukee; Engr. with, and member of firm, Robert Cramer & Sons, Cons. Engrs., Milwaukee.

WENZEL, LELAND KEITH, Washington, D.C. (Age 32) (Claims RCA 5.4 RCM 3.5) Dec. 1929 to date with U.S. Geological Survey, as Jun. Hydr. Engr., Asst. Hydr. Engr., Associate Hydr. Engr., and (since Nov. 1940) Hydr. Engr.

APPLYING FOR JUNIOR

FRIES, WILLIAM ROBERT, Chicago, Ill. (Age 27) June 1937 to date with Crane Co., at present Sales Engr., Water & Sewage Works Dept.

GREEN, WILLIAM WELLS, Corpus Christi, Tex. (Age 29) June 1940 to date at Corpus Christi, Tex., 2 weeks as Office Engr. with Myers & Noyes, and since July 1940 Inspector and Office Engr., City Engr.'s Office; previously Instructor in Civ Eng., St. Edwards Univ., Austin, Tex.; with Iowa State Highway Comm.

HANSEN, MELVILLE BIRGER, Woodfibre, B.C., Canada. (Age 26) 1940 B.A., Univ. of British Columbia; May 1940 to date Asst. Engr., British Columbia Pulp and Paper Co., Ltd.

HARDENBERGH, DONALD EDWARD, Harrisburg, Pa. (Age 23) Oct. 1940 to date Senior Hydrographer, Federal-State Flood Forecasting Service, Pennsylvania Dept. of Forests and Waters; previously Jun. Constr. Inspector and Instrumentman, Pennsylvania Dept. of Highways; Instrumentman and Draftsman with C. S. Hardenbergh, Registered Civ., Min., and Cons. Engr.

LEFFERTS, HORACE LEEDOM, Diablo Heights, Canal Zone. (Age 26) Aug. 1940 to date Jun. Engr., The Panama Canal, Canal Zone; previously Jun. Engr., Dept. of San. Eng., and Asst. Eng. Draftsman, Water Div., both of Washington, D.C.

LIBNER, HARRY RICHARD, Rock Island, Ill. (Age 30) (Claims RCA 4.3) July 1936 to date with U.S. Engr. Office, as Asst. Inspector (G.C.), Jun. Engr. (Hydr.), and (since Aug. 1939) Asst. Engr. (Hydr.); previously Office and Field Supervisor, Bureau of Labor Statistics, WPA and FERA.

McCARTHY, DANIEL VINCENT, Rock Island, Ill. (Age 27) (Claims RCA 3.8) Sept. 1935 to date with U.S. Engrs., as Asst. Eng. Aide, Jun. Engr., Asst. Engr., and (since July 1939) Associate Engr.

McKENZIE, ANDREW JACKSON, JR., Dallas, Tex. (Age 27) (Claims RCA 0.7) June 1934–March 1940 with McKenzie Constr. Co., and April 1940 to date Pres., M. & M. Constr. Co.

MADDEN, EDWARD BINGHAM, Little Rock, Ark. (Age 28) Feb. 1939 to date Jun. Hydr. Engr., U.S. Engr. Office; previously Under Eng. Aide to Jun. Hydr. Engr., TVA, Knoxville, Tenn.

MERCER, ROBERT TRESSLER, Portland, Ore. (Age 22) 1940 completed requirements for degree of B.S. in Civ. Eng., Ore. State Coll. (degree to be conferred in June 1941); at present Office Engr. with L. B. James, Gen. Contr.

1940 GRADUATES

BROOKLYN POL. INST.
(B.C.E.)

Age

WARSHAW, SEYMOUR (22)

CALIF. INST. TECH.
(M.S.)

USTEL, SABIH AZIZ (22)
(Also 1939 B.S. in C.E., Robert Coll., Istanbul, Turkey)

(B.S. in Eng.)

HOFMAN, WALTER (21)

CATHOLIC UNIV. OF AMERICA
(B. in Archt. Eng.)

DEEGAN, JOHN WILLIAM (22)

(B.C.E.)

SCULLEN, ANTHONY JAMES, JR. (21)

LEWIS INST.
(B.S. in C.E.)

GRAHAM, DONALD MACDIARMID (21)

UNIV. OF MINN.
(B.S.C.E.)

HURTLEY, WALTER ALEXANDER (26)
TITUS, JOHN PHILIP (23)

MISS. STATE COLL.
(B.S. in C.E.)

HIGH, LESTER GRAYSON (22)

COLL. OF CITY OF N.Y.
(M.C.E.)

HUSAR, EMILE (25)
(Also 1938 B.C.E.)

N.Y. UNIV.
(B.C.E.)

FAJMAN, WILLIAM JOSEPH (25)
FETTIS, WILLIAM GEORGE, JR. (27)
GERALDE, JOHN JAMES (24)
GUARNERA, SALVATORE (23)
KRAPP, CHARLES ALBERT (24)

UNIV. OF WIS.
(B.S. in Civ. Eng.)

DIETZ, JESSE CLAY, JR. (26)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Smooth riding comfort . . . combined with the longest life and lowest upkeep of any widely used pavement.

Always the least costly... now the best riding

A swift succession of important advances in brick pavement construction have followed each other throughout the past few years.

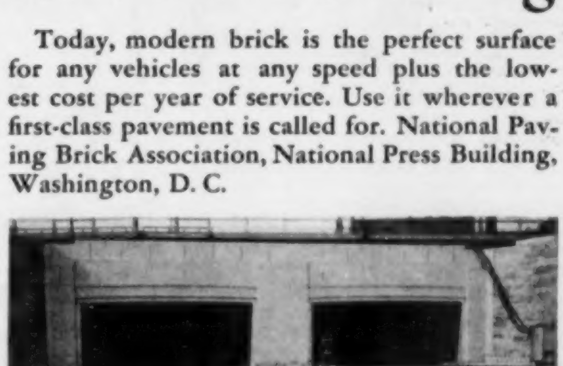
Result: Modern brick pavements are unexcelled in riding qualities.

There have been advances in technique such as surface filler removal and rolling on boards. There have been basic structural improvements such as the mastic cushion and manufacturing progress such as wire-cut vertical fibre wearing surfaces and de-airing.

Hence, modern brick is a streamlined version of the pavement type that has longest life and lowest maintenance.

This progress comes at a time when it is most useful. For now it is known that brick has by far the greatest resistance to weather damage—starting point of most pavement failures.

Today, modern brick is the perfect surface for any vehicles at any speed plus the lowest cost per year of service. Use it wherever a first-class pavement is called for. National Paving Brick Association, National Press Building, Washington, D. C.



Entrance to Queens-Midtown Tunnel — New York City

VITRIFIED BRICK

THE MOST SATISFACTORY PAVEMENT

Men Available

These items are from information furnished by the Engineering Societies Personnel Service, Inc., with offices in Chicago, Detroit, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 132 of the 1940 Year Book of the Society. To expedite publication, notices should be sent direct to the Personnel Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago, Detroit, or San Francisco follows the key number, when it should be sent to the office designated.

Construction

Civil Engineer; M. Am. Soc. C.E., 1919; B.S.C.E., 1909; registered professional engineer, Texas; 30-year construction experience, concrete and earth-fill dams; river and harbor improvements, pile driving, hydraulic dredge, factory building construction; just released from complete charge of 45-million dam for Mexican government. Available February 1. C-813.

Civil Engineer; Jun. Am. Soc. C.E.; 30; B.S. in C.E.; professional engineer's license; 5 years varied heavy construction experience; $2^1/_2$ years responsible building experience, field and office; familiar with War Department specifications, construction methods, contracts, purchasing. Now employed in professional capacity, but desires position offering more responsibility and advancement. C-814.

Industrial

Hydraulic and Concrete Engineer; Assoc. M. Am. Soc. C.E.; experience in the field as well as in the office; 25 years experience in hydroelectrics; thorough training in planning, design, estimate, and detail; desires new engagement. C-806.

Safety Engineer; M. Am. Soc. C.E.; available for full or part-time service anywhere east of Kansas City and north of Louisville. C-811.

Junior

Civil Engineer; Jun. Am. Soc. C.E.; single; civil engineering graduate, New York University; desires position as junior engineer. Has following experience: town inspector, road and sewer construction, 2 years; junior engineer and draftsman, 1 year; cement tester for Board of Water Supply, $2^1/_2$ months. Salary reasonable; location New York City and vicinity. C-809.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. from Drexel Institute of Technology, 1939; 9 months varied experience in construction prior to graduation; one year of experience in highway construction, including inspection and drafting, since graduation. Desires position with opportunity for advancement in construction field; will go anywhere. C-810.

Municipal

Registered Engineer; Assoc. M. Am. Soc. C.E.; employed as city engineer and water-works superintendent in Southern industrial town for last six years, but wishes new connection with future; technical graduate with 14 years experience, mostly in construction. Available after reasonable notice. C-808.

Constructing or Supervising Engineer; Assoc. M. Am. Soc. C.E.; 54; married; water-works management, design; experienced in public relations, valuation; design and operation of water works; municipal engineering. Available immediately; Western states preferred. C-807-4012-A-1-San Francisco.

Teaching

Civil Engineer; Assoc. M. Am. Soc. C.E.; 32; B.S.C.E. and C.E. degrees; 9 years experience, including highway surveys, bridge surveys, work with contractor, and five years teaching; at present assistant professor of civil engineering teaching surveying, highways, and structural design. Engineers' license in Indiana and Alabama; design or construction. Available June 1. C-812.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

A. S. T. M. Standards on Cement, prepared by Committee C-1 on Cement, Sept. 1940. American Society for Testing Materials, Philadelphia, 1940. 103 pp., illus., diagrs., charts, tables, 9 × 6 in., paper, $1.

Twelve standard and tentative standard specifications, methods of chemical analysis, and physical tests pertaining to cement are presented in this pamphlet. There are also included the "Manual of Cement Testing" and a list of selected references on portland cement.

Cofferdams. By Lazarus White and Edmund Astley Prentis. Columbia University Press, New York (2960 Broadway), 1940. 304 pp., illus., tables, diagrs., charts, $9^1/_2$ × 6 in., cloth, $7.50.

This book is a detailed technical description of underpinning, underpinning methods, and applications to foundation construction. Written for engineers, architects, and contractors by engineers of long experience, it describes in detail actual cases of every type.

(The) Development of Mathematics. By E. T. Bell. McGraw-Hill Book Co., New York and London, 1940. 583 pp., $9^1/_2$ × 6 in., cloth, $4.50.

The author presents a broad account of the part played by mathematics in the evolution of civilization, describing clearly the main principles, methods, and theories of mathematics that have survived from about 4000 B.C. to the present time. Details of antiquarian interest are subordinated to a fuller exposition of things still alive in mathematics than is customary in histories.

Great Britain. Home Office. Air Raid Precautions. Specifications, etc., in regard to Permanent Lining of Trenches. H. M. Stationery Office, London, 1939. 8 pp., diagrs., 13 × $8^1/_2$ in., paper (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 10 cents).

The composite specification and bill of quantities are given for precast concrete trench-lining units, accompanied by diagrammatic drawings. There are also a general specification for the permanent lining of trenches and a Home Office circular letter giving basic information on trench construction.

Great Britain, Department of Scientific and Industrial Research. Building Research. Wartime Building Bulletin No. 9, Conservation of Cement and of Clay Bricks. His Majesty's Stationery Office, London, 1940. 22 pp., diagrs., charts, tables, 11 × $8^1/_2$ in., paper, 1s. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 30 cents.)

This pamphlet calls attention to ways in which substitutes can be used for cement and clay brick in many cases and to ways in which these materials can be used most economically where no alternative is available. Specifications are given for tar macadam roadways, for economical concrete floors, and for methods of making walls.

Great Britain, Dept. of Scientific and Industrial Research. Building Research. Technical Paper No. 21. Studies in Reinforced Concrete, IV. Further Investigations on the Creep or Flow of Concrete Under Load, by W. H. Glanville and F. G. Thomas. His Majesty's Stationery Office, London, 1939. 44 pp., illus., diagrs., charts, tables, $9^1/_2$ × 6 in., paper, 1s. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 30 cents.)

Continuing the work presented in Technical Paper No. 12, results are given from further investigation of prolonged loading tests on small cylinders of plain concrete and on reinforced concrete columns. The scope of the investigation has been widened to include creep in pure tension, lateral movements under compression, and the effect of creep on the deformation and ultimate strength of reinforced-concrete beams. An example from practice of the movements resulting from shrinkage and creep is included.

Housing for Defense—A Review of the Role of Housing in Relation to America's Defense. Factual findings by Miles L. Colean and the program for action by the Housing Committee of The Twentieth Century Fund. The Twentieth Century Fund, New York (330 West 42d Street), 1940. 208 pp., tables, diagrs., charts, paper boards, $1.50.

This volume has been prepared as an emergency report on housing as related to national defense. It reviews the experience of the last war and attempts, in the light of this hindsight, to develop some foresight for the immediate future. The report was undertaken with the knowledge and interest of the Advisory Commission to the Council of National Defense, though the findings and recommendations are entirely those of the Fund's Committee.

Materials Handbook, 4 ed. By G. S. Brady. McGraw-Hill Book Co., New York and London, 1940. 591 pp., charts, tables, $9^1/_2$ × 6 in., leather cloth, $5.

The many materials used in industry are identified and described in this concise encyclopedic reference book. Information is given on physical and chemical properties, constitution, and uses. The materials vary from such basic raw materials as mineral ores and woods to such products as alloy steels and synthetic resins. Intended primarily for purchasing agents and industrial executives, its field is much wider for reference use. Useful tables are appended.

Public Utilities and the National Power Policies. By J. C. Bonbright. Columbia University Press, New York, 1940. 82 pp., 9 × $5^1/_2$ in., cloth, $1.25.

This sketch of the New Deal power policies discusses the control of public utilities, rate regulation, holding companies, etc., and their relation to the question of public ownership. The electric light and power industry is used as an example, and the criticisms of present government policy are discussed. Suggestions are given for further reading.

Sewage-Treatment Works. By C. E. Keefer. McGraw-Hill Book Co., Inc., New York, 1940. 673 pp., illus., tables, diagrs., charts, 9 × 6 in., cloth, $6.

In preparing this book emphasis has been placed on treatment processes that are widely used. Although the volume is intended primarily for operators of sewage plants in America, it should be of service to foreign readers, too. Designers of sewage plants, who should of necessity be familiar with operating problems and their solution, will also find it of assistance.

Steam-Turbine Principles and Practice, 2 ed. By T. Croft; revised by S. A. Tucker. McGraw-Hill Book Co., New York, 1940. 298 pp., illus., diagrs., charts, tables, $8^1/_2$ × 6 in., cloth, $3.

This book gives the operating engineer, the plant superintendent, and the manager the information necessary for the successful and economical selection and operation of steam turbines. It covers installation, lubrication, testing, and maintenance with special attention given to the economics of steam-turbine operation. The new edition has been generally revised to conform to current practice and has a new chapter describing the engineering principles involved in turbine selection and heat balance.

Technical Exposition. By L. M. Oliver. McGraw-Hill Book Co., New York, 1940. 193 pp., charts, $8^1/_2$ × $5^1/_2$ in., cloth, $1.50.

This text in advanced English for engineers presents a series of basic expository problems, with assignments for students, and a full discussion of theory and practice in the field of research, papers, and reports. There are also sections on the fundamentals of business-letter practice and on vocabulary and punctuation.

Tilt of the Aerial Photograph by Graphical Resection. By R. O. Anderson. The author (Box 882), Chattanooga, Tenn., September 1940. 50 pp., diagrs., charts, tables, 8 × $5^1/_2$ in., paper, $1.

This pamphlet, which constitutes a supplement to the author's "Applied Photogrammetry," consists of three new methods of computing the scale and tilt of the aerial photograph covering cases of excessive tilt and, also, cases when the scale points fall upon a straight line. This method, which is effective for all positions of the scale points except the condition of the three scale points coinciding, is treated in detail as it consists of several recently developed principles that differ widely from the Dropped Perpendicular Method, presented in "Applied Photogrammetry." The other two methods—Residual Tilt and Oblique Calibrations—are shown in Appendixes I and II. In a general way the scope of the work may be stated as "The Rectification of the Tilted and Warped Surface."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BRIDGES

ABUTMENTS, STRESSES. Horizontal Forces and Moments on Bridge Abutments and Retaining Walls, E. I. Fiesenheiser. *Pub. Roads*, vol. 21, no. 9, Nov. 1940, pp. 167–171. Theoretical mathematical discussion of effect of concentrated moving live loads on fill back of bridge abutments and retaining walls; methods of computing overturning effect of live loads by taking into account distribution of stresses through soil; equations for force and moment based on theoretical variation of stress; determination of position of live load for maximum moment; charts presented.

APPROACHES. Reconstruction of Approach Spans of Grafton Bridge, A. J. Dickson. *New Zealand Instn. Engrs.—Proc.*, vol. 26, 1939–1940, pp. 32–54, (discussion) pp. 54–72. Report on reconstruction of Vierendeel truss approaches of Grafton Bridge, at Auckland, New Zealand, at cost of about £22,000; stress conditions in existing girders; design of timber falsework.

CONCRETE, QUEBEC. World's Largest Precast Concrete Bridge Span. *Eng. & Contract Rec.*, vol. 53, no. 36, Sept. 4, 1940, pp. 9–11. Construction of concrete slab 2-track railroad bridge crossing highway on Island of Montreal, Quebec, using pre-cast concrete slabs, weighing 135 tons, 77 ft long.

PIERS, CONSTRUCTION. Constructing 360-Ft. Piers. *Western Construction News*, vol. 15, no. 11, Nov. 1940, pp. 381–384. Construction of two 360-ft concrete piers, which are to support double-deck cantilever section of Pit River Bridge of railroad relocation around Shasta Reservoir, California; preliminary work; contractor's plant; placing concrete; forms; mixes used; cooling system; height of pours; topping out piers.

PONTOON, WASHINGTON. Designing and Building Lake Washington Bridge, C. E. Andrew. *Am. Highways*, vol. 19, no. 4, Oct. 1940, pp. 28–32. Non-technical report on design and construction of Lake Washington pontoon bridge described in many previously indexed articles.

RAILROAD CROSSINGS, ELIMINATION. Welded Underpass, C. Darby. *Western Construction News*, vol. 15, no. 11, Nov. 1940, pp. 378–379. Construction of underpass on 22-deg curve, at Oregon City, Ore., featuring welded transverse beams and ballast trough, built under railroad traffic; methods and costs; handrail and floor; costs of welds.

RAILROAD CROSSINGS, MONTANA. Wolf Point Underpass, R. A. Stephenson. *Roads & Streets*, vol. 83, no. 11, Nov. 1940, pp. 33–36. Description of $130,000 highway underpass beneath main line of Great Northern Railway Co. at Wolf Point, Mont., featuring method of sealing out ground water by means of concrete subslab; subslab design and construction; contract prices.

STEEL TRUSS, INDIA. Howrah Bridge. Erection of Steelwork Proceeds. *Civ. Eng.* (London), vol. 35, no. 411, Sept. 1940, pp. 256–257. Progress report on construction of steel truss bridge in Calcutta, India, 2,150 ft long, comprising two cantilever arms, 468 ft long, and central suspended span, 564 ft long; stages in erection of steelwork.

STEEL TRUSS, KROTZ SPRINGS, LA. Novel Bridge Lengthening in America. *Ry. Gaz.*, vol. 73, no. 16, Oct. 18, 1940, pp. 407–408. Simple truss span bridge lengthened to 1,920 ft by inserting 720-ft cantilever structure; main cellular caisson piers and their sinking are of unusual interest. From *Eng. News-Rec.*, July 4, 1940.

SUSPENSION, FAILURE. Aerodynamic Stability of Suspension Bridges, T. von Kármán. *Eng. News-Rec.*, vol. 125, no. 21, Nov. 21, 1940, p. 670. Letter to editor containing theoretical mathematical discussion of possible cause of failure of Tacoma Narrows suspension bridge due to its aerodynamic instability.

VIADUCTS, MAINTENANCE AND REPAIR. Methods Employed in Rehabilitation of High Concrete Viaduct, R. Van Brimmer. *Pub. Works*, vol. 71, no. 9, Sept. 1940, pp. 16–18. Repair and reconstruction of reinforced concrete North Hill Viaduct, Akron, Ohio, consisting of 16 arches and two beam-and-girder approach spans, with total length of 2,840 ft.

VIADUCTS, MASONRY ARCH. Wiederherstellung einer stark beschaedigten steinernen Talbruecke, Leopold. *Bautechnik*, vol. 18, no. 35, Aug. 16, 1940, pp. 401–404. Description of methods and equipment used in repairing badly deteriorated 65-year-old German masonry arch viaduct, carrying two railroad tracks; consists of 12 spans 20 m long; maximum height 27 m.

WELDING, STRUCTURAL STEEL. Welding Steel Members for Bridge Work. *Commonwealth Engr.*, vol. 28, no. 3, Oct. 1, 1940, pp. 93–94. Discussion of practice of Department of Main Roads, New South Wales, in connection with welding of plate girders and trusses for steel bridges.

BUILDINGS

AIR CONDITIONING. Air-Conditioning New 28-Story Office Building. *Sheet Metal Worker*, vol. 31, no. 10, Oct. 1940, pp. 44, 46, and 62. Details of air-conditioning system for 28-story office structure (Unit 2), built for Metropolitan Life Insurance Co.; plant involves automatically controlled air supply of suitable temperature to compensate for outside weather conditions in all seasons; most of vitiated air is exhausted to atmosphere; exhaust ducts terminate almost flush with roof line; actual openings are covered with subway type gridwork.

ANTI-AIRCRAFT PROTECTION, SHELTERS. Air Raids and Structures, G. P. Manning. *Concrete & Constr. Eng.*, vol. 35, no. 7, July 1940, pp. 320–327. Theoretical discussion of principle that all structures should be designed to resist definite lateral pressure, depending on amount of shelter they are expected to afford; strength of two-story brick building; strength of multi-story brick buildings; total effective structural pressure from bomb; comparison of brick and concrete shelters; trench shelters; multiple-skin shelters; shelters in framed buildings.

FOUNDATIONS. Unusual Foundation Job, E. H. Darling. *Eng. J.*, vol. 23, no. 11, Nov. 1940, pp. 459–463. Description of extensive alterations to basement of department store of T. Eaton Co., at Hamilton, Ont.; procedure and equipment used in shoring 6-story reinforced flat-slab type concrete building and in lowering foundation 3 ft.

NATIONAL DEFENSE, UNITED STATES. Building for National Defense. *Arch. Forum*, vol. 73, no. 5, Nov. 1940, pp. 321–468, and 10 pp. between pp. 58–82. Symposium on planning and construction for national defense of United States in 1917 and 1918 and in 1940: Organization: defense building agencies; role of building industry; military and naval buildings; industrial buildings; defense plan for city; air-raid protection; housing. 16-page bibliography.

CITY AND REGIONAL PLANNING

HIGHWAY SYSTEMS. Planning for City Superhighways. *Better Roads*, vol. 10, no. 8, Aug. 1940, pp. 15–17 and 31. Review of report of Highways and Transportation Committee of American Society of Planning Officials, urging use of more planning prior to constructing city superhighways; application of traffic engineering before need for superhighways is measured; consideration of mass transit facilities, and obtaining and preserving proper right of way. Report also urges that planning be responsibility of local planning agencies.

NATIONAL DEFENSE. Defense-Time Planning for Peace-Time Use, P. Goodman. *Arch. Rec.*, vol. 88, no. 5 Nov. 1940, pp. 95–98. General discussion of planning of war-time settlements with special reference to concentration vs. decentralization of new industry and convertibility from war- to peace-time use.

ROADS AND STREETS, INTERSECTIONS. Der Slussen, Stockholms grosser Verkehrsmittelpunkt, C. Eckmann. *Schweizerische Bauzeitung*, vol. 116, no. 5, Aug. 3, 1940, pp. 54–56. Layout of complicated intersections and ramps for heavy street traffic in Slussen district of Stockholm, Sweden.

CONCRETE

BEAMS. L'effort Tranchant en béton armé, G. Magnel. *Assn. des Ingénieurs Sortis des Écoles Spéciales de Gand-Annales*, vol. 29, no 4, 1939, pp. 567–650. Theoretical mathematical discussion of shearing stresses in simple and continuous beams; design of shear reinforcement; bond between steel and concrete.

CONSTRUCTION, COLD WEATHER. Rapid Construction at Extremes of Temperature, S. Gottlieb. *Concrete & Constr. Eng.*, vol. 35, no. 4, Apr. 1940, pp. 186–190. Account of concrete works successfully carried out at temperatures as low as zero F; results of tests on hardening of aluminous cement at high temperatures; influence of various mixing times on hardening.

CONSTRUCTION, NATIONAL DEFENSE. Concrete Structures Built Without Steel or Timber. *Concrete & Constr. Eng.*, vol. 35, no. 2, Feb. 1940, pp. 59–62. Editorial discussion of construction of military huts making considerable use of precast concrete hollow units; pre-cast concrete voussoirs without reinforcement.

CONSTRUCTION, PRE-STRESSING. Saving Reinforcement by Pre-Stressing, P. Abeles. *Concrete & Constr. Eng.*, vol. 35, no. 7, July 1940, pp. 328–333. Review of progress in concrete construction using pre-stressed reinforcement; prestressing by Freyssinet's method; tie rods without bend; combination of normal reinforcement and additional stretched wires; method of stretching wires; use of high-grade steel.

IRRIGATION CANALS, LINING. Machine Methods of Canal Lining. *Reclamation Era*, vol. 30, no. 8, Aug. 1940, pp. 222–225. Description of equipment and methods used in concrete lining of irrigation canals on Roza division of Yakima Project; trimming and compacting subgrade; method of placing and consolidating of lining.

DAMS

CONCRETE, AUSTRALIA. Construction of Goolwa Barrage, E. R. Lawrie. *Instn. Engrs. Australia—J.*, vol. 12, no. 8, Aug. 1940, pp. 221-231. Design and construction of one of series of concrete barrages for prevention of salt water intrusion into mouth of Murray River, Australia; features of reinforced concrete barrage based on foundation slab supported on timber pile foundation with sheet-pile cut-off wall 40 ft deep; cofferdam construction; shore plant layout; excavation; foundation piles; stop logs; features of navigation lock and navigable pass.

CONCRETE GRAVITY, WASHINGTON. Dam the Accidents! H. G. Danford and F. W. Johnson. *Safety Eng.*, vol. 80, no. 5, Nov. 1940, pp. 6–8 and 10. Methods and equipment used in preventing accidents on Grand Coulee Dam; safety rules and regulations.

EARTH, ASPHALT COATINGS. Asphalt Facing on Debris Dam, W. E. Christison. *Western Construction News*, vol. 15, no. 11, Nov. 1940, pp. 370–371. Construction of 3-in. asphaltic concrete pavements on upstream slope of earthfill dam known as Stough Canyon Debris Dam, near Burbank, Calif., 37 ft high and 255 ft long; lining of 1,200 ft of wasteway channel with same material.

EARTH, COLORADO. Earthfill Construction, Green Mountain Dam, Colorado-Big Thompson Project, Colorado, R. B. Ward. *Reclamation Era*, vol. 30, no. 10, Oct. 1940, pp. 289–290. Description of special equipment and methods used for separating earth materials for construction of Green Mountain earthfill dam in Colorado.

EARTH, TESTING. Messungen an Staudammen, J. Ehrenberg. *VDI Zeit*, vol. 84, no. 28, July 13, 1940, pp. 495–500. Discussion of German methods and equipment for measurement of vertical and horizontal displacements in earth

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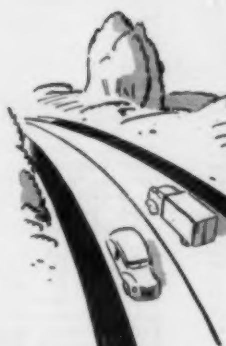

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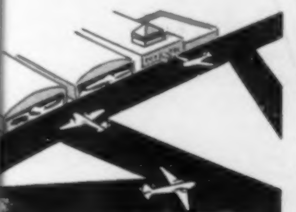

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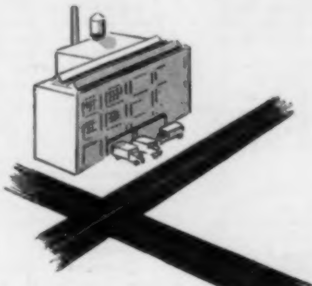

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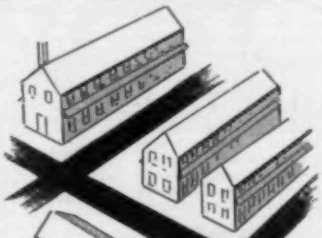

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dams; determination of foundation pressures of earth dams; measurement of quantity and stage of water in earth dams.

GRAVITY, DESIGN. Der Einfluss der Mauerkruemmung auf die Bemessung von Gewichtstaumauern, H. Link. *Bautechnik*, vol. 18, no. 42, Sept. 27, 1940, pp. 488–490. Theoretical mathematical discussion of effect of curved alinement on design of vertical and inclined gravity dams; safety against sliding; numerical examples.

ICE CONTROL. Induction Heating Applied to Coulee Drum Gates, R. D. Goodrich, Jr. *Elec. West.*, vol. 85, no. 4, Oct. 1940, pp. 46–48. Tests show superiority of induction system in which 78% of heat is developed in iron; each of eleven 115-ft gates requires 215 kva to stop freezing; view of arrangement of conductors within pier plate and wiring diagram given.

MOVABLE. Rollschuetze fuer grosse Durchflussweiten, M. Laufer. *Bautechnik*, vol. 18, nos. 44–45, Oct. 18, 1940, pp. 515–519. Principles of design and construction of collapsible weir and dam crests for spans as long as 30 m.

RESERVOIRS, CONTROL STRUCTURES. Hydraulic Model Studies of Control Structures for Denison Dam, Red River. *U.S. Waterways Experiment Station—Tech. Memo. No. 161–161*, Apr. 15, 1940, 52 pp., supp. figs., tables, diagrs. Detailed report on tests of models of intake structures and conduits, stilling basins and tailrace of reservoir formed by earthfill dam at Denison, Tex.

RESERVOIRS, DESIGN. Capacity Requirements and Design of Distribution Reservoirs, R. C. Kennedy. *Am. Water Works Assn.—J.*, vol. 32, no. 11, Nov. 1940, pp. 1819–1833. Methods adopted by East Bay Municipal Utility District, Oakland, Calif., for determining storage capacities required in its distribution reservoirs; "depth-over-area" method of estimating demand; variations in consumption; back-feed method of adding to distribution system capacity; design features of earth, pre-stressed concrete, and steel reservoirs.

ROCKFILL, REPAIR. Timber Facing Prevents Dam Leakage, P. Baumann. *Eng. News-Rec.*, vol. 125, no. 21, Nov. 21, 1940, p. 683. Data on performance of laminated timber facing of San Gabriel Dam No. 2, California; reducing leakage through rockfill from 124 cu ft per sec to 11 cu ft per sec; cost of maintenance and repairs of timber facing.

FLOOD CONTROL

EGYPT. Hydraulic Features of Nile Flood of 1938. *Egypt Ministry Pub. Works—Irrigation Dept.—Hydraulic Sec., 1940.* 30 pp., diagrs., tables. Study of 1938 flood of Nile River, Egypt; statistical information on hydraulic features of flood including comparisons of Nile floods in previous years; water taken from river in Upper Egypt during flood; water returned from basins into river; gains and losses in river during flood; fall of 1938 flood; discharges of river during 1938 flood; regulation on barrages during 1938 flood.

LOUISIANA. Wax Lake Outlet and Charenton Drainage and Navigation Canal, W. F. Tompkins. *La. Eng. Soc.—Proc.*, vol. 26, no. 1, Feb. 1940, pp. 16–31. Discussion of large-scale flood-control improvement at south end of Atchafalaya River channel near Morgan City, La.

FOUNDATIONS

BRIDGE PIERS, CONSTRUCTION. Z-Piling for Bridge Pier Shafts, L. K. Whitcomb, Jr. *Eng. News-Rec.*, vol. 125, no. 21, Nov. 21, 1940, pp. 684–686. Construction of piers for bridge over Tuscarawas River at Dover, Ohio, using Z-piling in shape of double cross driven for skin friction bearing in sand-gravel strata containing some clay, with Z-pile box above solid foundation material filled with concrete for additional bearing and rigidity; old bridge used as falsework; advantages of Z-piles.

BUILDINGS, UNDERPINNINGS. American Practice Relating to Underpinning of Buildings Contiguous to Excavations, R. P. Miller. *Bldg. Standards Monthly*, vol. 9, no. 11, Nov. 1940, pp. 4–8. Analysis of reports from 52 cities in United States on prevailing local practice for underpinning of buildings contiguous to excavations; summary of requirements of laws relating to this matter.

EMBANKMENTS, SETTLEMENTS. Settlement of Earth Embankments, L. A. Palmer and E. S. Barber. *Pub.-Roads*, vol. 21, no. 9, Nov. 1940, pp. 161–166 and 172–173. Results of theoretical and experimental studies of highway embankment settlement resulting from lateral displacement of soil, as distinguished from settlement caused by consolidation, making use of principle of stationary flow of plastic mass; settlement of fill under its own weight; settlement of undersoil.

RETAINING WALLS, EARTH PRESSURE. Pressure of Earth Against Lateral Supports, R. R. Minikin. *Engineer*, vol. 170, no. 4423, Oct. 18, 1940, pp. 244–246. After several decades of experience with earth works, author decided to experiment on more generous scale with simple apparatus and devised simple apparatus which fulfilled elementary conditions of test; conclusions summarized from tabulated and graph results of observations.

HYDRAULIC ENGINEERING

PORT STRUCTURES, BUDAPEST, HUNGARY. Der Plan des Nordhafens in Budapest, R. Papp. *Bautechnik*, vol. 18, no. 32, July 26, 1940, pp. 367–369. Report on hydraulic model tests and other preliminary investigations for design and construction of new basins for Danube River port at Budapest, Hungary.

PROTECTIVE COATINGS. Protective Coatings for Hydro Structures, L. J. Pospisil. *Elec. West.*, vol. 84, no. 6, June 1940, pp. 127–128. In 1926, Washington Water Co. began to apply bituminous enamel coating to its penstocks; examinations since have shown that in penstocks where water velocities are not exceptionally high, coating is in excellent condition.

HYDROELECTRIC POWER PLANTS

SOVIET UNION. Die Wolga-Stauanlage in Kujbyschew, H. Saler. *Bautechnik*, vol. 18, no. 42, Sept. 27, 1940, pp. 486–468. Outline of plant for development (to be completed by 1950) of Middle Volga River in U.S.S.R. for hydroelectric generation of 3,400,000 kw, also for irrigation of vast tracts of land and improvement of navigation, involving construction of concrete overflow dam 950 m long and earth embankment, 2,500 m long, 45 m high, at Kuybishev, formerly Samara; also two canal locks overcoming difference of elevation of 30 m.

HYDROLOGY AND METEOROLOGY

BEACHES, EROSION. Report on Studies in Orange County. *Shore & Beach*, vol. 8, no. 4, Oct. 1940, pp. 110–113 and 126–129. Report on California investigation by Beach Erosion Board, covering 22-mile section of ocean front in Orange County, California; figures on amount of beach building material that is being withheld by construction of upland flood control and soil erosion prevention projects; shore line changes; offshore changes; effect of storms, offshore swells, waves, and currents; submarine canyon influence on wave height; sand movement; plans of improvement.

BEACHES, EROSION. Southern California Beach Erosion, A. G. Johnson. *Shore & Beach*, vol. 8, no. 4, Oct. 1940, pp. 106–109 and 120. Discussion of beach erosion caused by activities of man; natural processes which create and maintain Southern California beaches; criticism of breakwaters at Santa Barbara and Redondo Beach, Southern California; long-range planning of beach improvements.

EARTHQUAKES, ROUMANIA. Rumanian Earthquake of November 10, E. Tillotson. *Nature* (London), vol. 146, no. 3708, Nov. 23, 1940, pp. 675–677. From information obtained, provisional isoseismal lines are constructed on Modified Mercalli Scale; shock reached intensity 10 on this scale in epicentral area but not 11 or 12, which are extremely rare; altogether, shock constituted one of great earthquakes of world, but not one of greatest.

RESERVOIRS, EVAPORATION. Use of Floating Pans in Lake Mead, T. E. Mead. *Reclamation Era*, vol. 30, no. 11, Nov. 1940, pp. 316–317. Description of procedure used in measuring evaporation from Lake Mead, formed by Boulder Dam, by means of evaporation pans.

STRUCTURES, EARTHQUAKE EFFECT. Earthquake Resistant Design, F. P. Ulrich. *Bldg. Standards Monthly*, vol. 9, no. 10, Oct. 1940, pp. 7–12. Discussion of application of principles of earthquake-resistive design; need of experienced judgment; analysis of seismograph records; strong motion seismographs; observations of building vibration; earthquake prediction.

IRRIGATION

AIRPORTS. Airports Serving Federal Reclamation Projects, M. A. Schnurr. *Reclamation Era*, vol. 30, no. 10, Oct. 1940, pp. 280–284. Descriptive notes on 36 airports serving irrigation project territories of U.S. Bureau of Reclamation in Western states.

CANALS, LINING. Lining of Haveli Main Line Canal, R. S. Duncan. *Punjab Eng. Congress—Proc.*, Paper no. 221, vol. 27, 1939, pp. 39–57, (discussion) 57a–h, supp. plates. Methods and equipment used in lining irrigation canal in Punjab, India, 45.2 miles long; cost data; lining is made of sandwich of two layers of brick tiles in cement mortar with intermediate layer of cement plaster.

COLORADO. Colorado-Big Thompson Project, M. S. Bitner. *Reclamation Era*, vol. 30, no. 9, Sept. 1940, pp. 267–269. Description of Colorado-Big Thompson irrigation project for irrigation of 615,000 acres of Colorado farm land, also for supplying annually 360,000,000 kw-hr of firm hydroelectric power and 332,000,000 kw-hr of secondary power, comprising five reservoirs, six power, plants, two pumping plants, and 13-mile tunnel.

NEW MEXICO. Pre-Construction Investigations—Tucumcari Project, New Mexico, H. W. Mutch. *Reclamation Era*, vol. 30, no. 9, Sept. 1940, pp. 270–272. Report on pre-construction investigations of Tucumcari Irrigation Project in New Mexico, comprising 47,300 acres of irrigable land in New Mexico, including topographical and geological surveys, land classification work, etc.

UNITED STATES. Stabilization by Irrigation, E. B. Debler. *Reclamation Era*, vol. 30, no. 11, Nov. 1940, pp. 309–311. Discussion of irrigation characteristics of western United States; provisions of Reclamation Appropriation Act of 1939; present and potential irrigation development in western United States.

MATERIALS TESTING

BEAMS, CONCRETE. Tests on Beams Reinforced with High-Tensile Steel and Mild Steel, G. Kazinczy. *Concrete & Constr. Eng.*, vol. 35, no. 5, May 1940, pp. 223–231. Report on tests conducted in order to ascertain whether high tensile steel may be used at its full permissible stress in ordinary grade concrete, leading to conclusion that, when reinforced with high tensile steel, working stresses of concrete may be raised at least to extent allowed by regulations.

CONCRETE. Designing Concrete Mixtures for Pavements, W. F. Kellermann. *Pub. Roads*, vol. 21, no. 7, Sept. 1940, pp. 121–126 and 138–139. Discussion of method of investigating flexural strength of concrete in connection with problem of designing concrete mixtures for pavements; results of laboratory tests which demonstrate how flexural strength may vary over wide range due to characteristics of aggregates employed; theories of mix design; chart for computation of mix design; relation between cement factor and flexural strength of concrete.

TESTING, FATIGUE. Fatigue of Concrete, F. C. Lea. *Concrete & Constr. Eng.*, vol. 35, no. 3, Mar. 1940, pp. 164–166. Report on tests in which reinforced concrete beams, 11 ft long by 12 in. deep by 6 in. wide, were subjected to rapidly alternating loads repeated a great number of times. Abstract of part of series of articles under heading Stresses, previously indexed from *Structural Engr.*, Jan. and Feb. 1940.

MUNICIPAL ENGINEERING

ANTI-AIRCRAFT PROTECTION. Air-Raid Protection from Engineering Point of View. *Concrete & Constr. Eng.*, vol. 34, no. 12, Dec. 1939, pp. 659–672. Summary of information; penetration of bombs; effects of high-explosive bombs; protection against blast and splinters; methods of providing shelter; trench shelters; trenches inside buildings; use of basements; adaptation of existing accommodation above ground.

ANTI-AIRCRAFT PROTECTION, SHELTERS. Structural Design of Air-Raid Shelters, D. H. Lee. *Concrete & Constr. Eng.*, vol. 35, no. 1, Jan. 1940, pp. 3–15 and 43–49. Selection of types of shelter; relative costs; details of construction; quantities of materials for partly sunk shelters of reinforced concrete for fifty persons; bomb-proof shelters; propped basements; waterproof construction; emergency exits.

PORTS AND MARITIME STRUCTURES

BREAKWATERS, DESIGN. Quebramares de Paredes Verticaes, A. Hor-Meyll. *Clube de Engenharia, Rio de Janerio—Revista*, vol. 6, no. 68, July-Aug. 1940, pp. 3–10. Breakwaters with vertical walls; extracts from general conclusions adopted at XVI Congress of Navigation at Brussels, in 1935; design features of some examples of breakwaters; discussion of failure of Mustapha Wall at Port of Alger.

JETTIES, TESTING. Permeability of Rock Jetty Models. *Shore & Beach*, vol. 8, no. 4, Oct. 1940, pp. 102–103 and 131–132. Results of experiments, conducted at U.S. Waterways Experiment Station, to determine relative permeabilities of small-scale models of all-stone jetties of "chip-stone-core" type of flow of clear water.

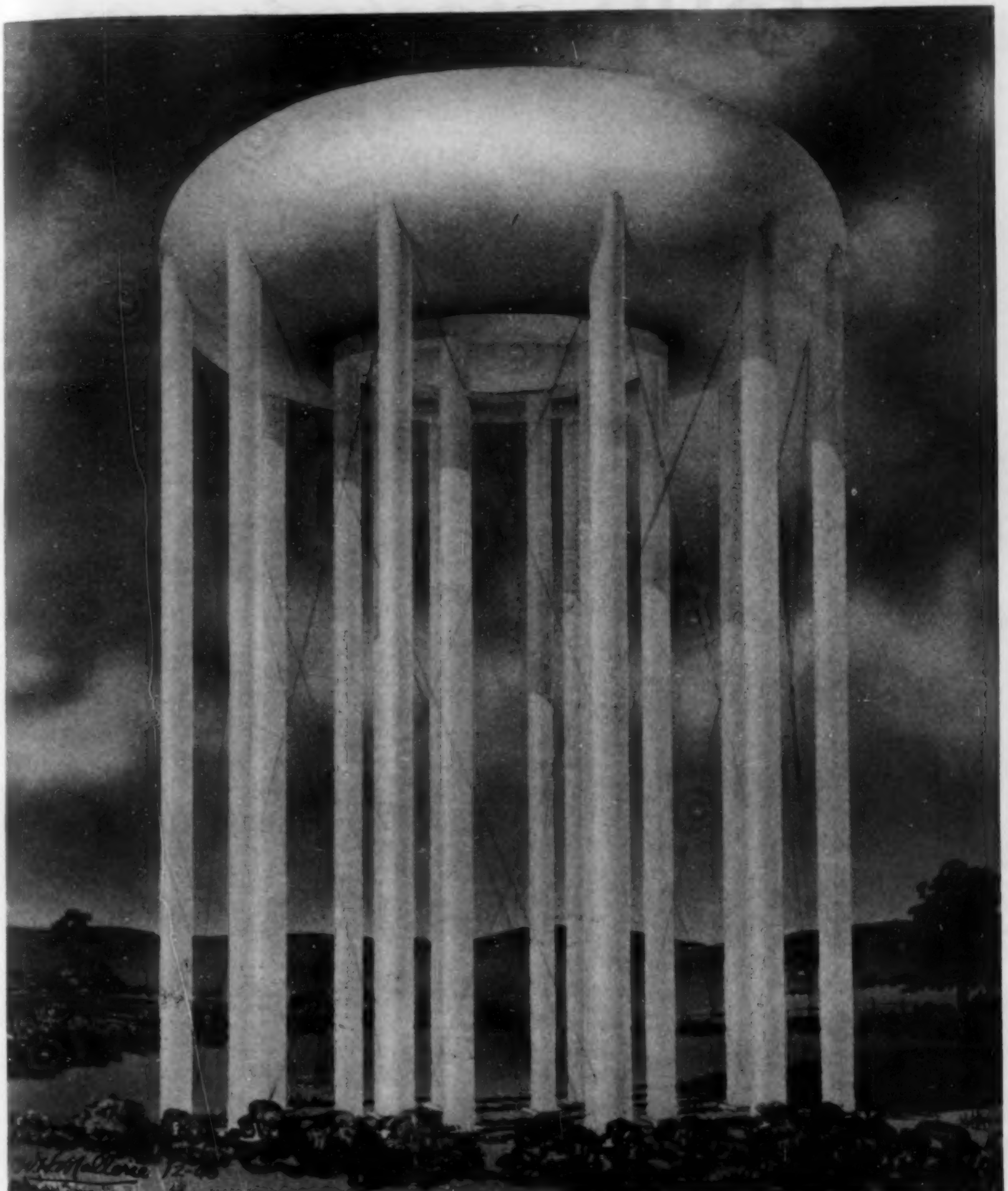
PORT STRUCTURES, BEIRA, EAST AFRICA. Port of Beira. Progress of Harbor Improvement Works. *Civ. Eng.* (London), vol. 35, no. 411, Sept. 1940, pp. 250–254. Construction of new deep-water wharves, warehouses, and other improvements in port of Beira, Portuguese East Africa; pile-screwing operations; shed foundations; land reclamation; description of fairway buoy.

RAILROADS, STATIONS, AND TERMINALS

RAILROAD CONSTRUCTION, BELGIUM. North-South Junction Railway, Brussels. *Engineering*, vol. 150, nos. 3886, 3887, and 3889, July 5, 1940, pp. 13–15 and 10; July 12, pp. 31–23; and July 26, pp. 74–75, and 70, supp. plates. Article was in advanced state of preparation when Belgium was invaded; work was inaugurated in 1903; junction line has total length of 3.1 km of which about two-thirds is in tunnel and remainder in cuttings or on viaducts; work involved rebuilding of South Station; construction of 6-track tunnel; building series of viaducts and retaining walls; rebuilding and raising level of North Station, etc.

RAILROAD CONSTRUCTION, WELDING. Recent Progress in Railway Welding Practice, O. Bondy. *Ry. Gas.*, vol. 73, no. 19, Nov. 8, 1940, pp. 484–488. Brief review of development in past 3 years; use of welding in buildings and bridges; rail welding; flash butt welding; oxyacetylene rail butt welding.

RAILROADS, NEW ZEALAND. New Zealand South Island Main Trunk Extension. *Ry. Gas.*, vol. 73, no. 14, Oct. 4, 1940, pp. 359–360. Notes on continuation of construction of 78-mile link necessary to complete 604-mile South Island main line which was abandoned in 1931; description of bridges and tunnels; sea erosion.



A New Design—the Spheroidal Elevated Water Tank

Spheroidal steel tanks, known as Hortonspheroids, are used extensively in the oil industry to store volatile liquids. It is natural that this design, which places all of the shell and bottom plates in tension, should be utilized in building elevated tanks of the self-supporting bottom type for the storage of water. The shape gives a smooth, streamlined appearance that is enhanced by the use of tubular columns.

CHICAGO BRIDGE & IRON COMPANY

Chicago..............2199 McCormick Bldg.	Boston.........1545 Consolidated Gas Bldg.	Tulsa......................1647 Hunt Bldg.
Detroit...................1541 LaFayette Bldg.	Philadelphia.......1652-1700 Walnut Street	Birmingham............1596 N. 50th Street
Cleveland......2263 Builders Exchange Bldg.	Dallas.................1485 Praetorian Bldg.	San Francisco.............1084 Rialto Bldg.
New York........3395—165 Broadway Bldg.	Houston...................918 Richmond Ave.	Los Angeles..............1456 Wm. Fox Bldg.

Plants in BIRMINGHAM, CHICAGO, and GREENVILLE, PENNA. In Canada—HORTON STEEL WORKS, LIMITED, FORT ERIE, ONT.

DEFENSE PROGRAM SURVEY SHOWS . . .

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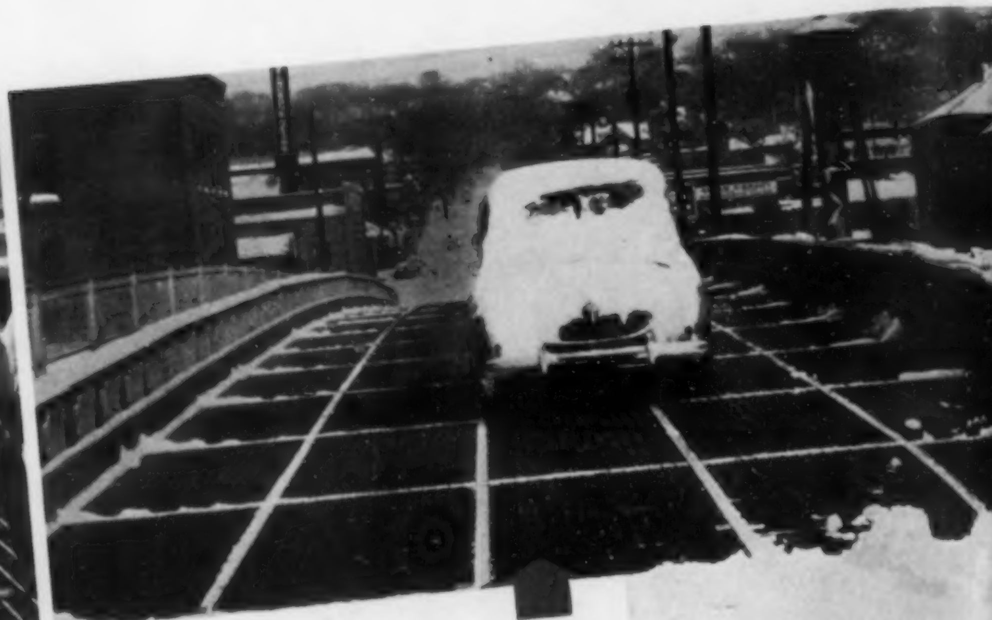

SELF-CLEANING. Typical scene in last winter's heavy snow-falls—bridge approaches snow covered, bridge deck clear. Snow simply falls through the large rectangular openings of I-BEAM-LOK Open Floor, makes it ideal construction where snow removal is a problem.

LONG SPANS, BIG SAVINGS. 107,500 sq. ft. of I-BEAM-LOK Concrete-filled Flooring on this 3200 ft. four-lane, 40′ crossing over the Monongahela River at Homestead, Pa. Though the 4¼″ I-BEAM-LOK Slabs easily carry H-20 highway loading they weigh only 55 lbs. per sq. ft., a reduction in dead load that was incorporated into the original bridge design, and saved thousands of dollars in the supporting structure.

CUTS REHANDLING COST. Laying 22,274 sq. ft. of 4¼″ I-BEAM-LOK Concrete-filled Flooring on Jerome Street Bridge, McKeesport, Pa. Note that heavy equipment can be run on the unfilled units as soon as they are in place. Thus concrete can be delivered on the job in transit-mixers and discharged exactly where required. No temporary runways or planking, no costly rehandling by workmen are needed.

LOAD LIMIT BOOSTED 66%. Old floor on this toll bridge at North Charleroi, Pa. weighed 49 lbs. per sq. ft., had permissible capacity of 12 tons per vehicle. Refloored this year with I-BEAM-LOK Open Flooring, and reinforced with new steel sub-floor, new floor complete now, weighs only 24 lbs. per sq. ft.—less than half the old construction. Bridge now has capacity for 20-ton vehicles.

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RAILROADS, PERU. Highest Standard Gauge Railway in World, T. G. Murdock. *Military Engr.*, vol. 32, no. 185, Sept.-Oct. 1940, pp. 332–337. Description of Central Railway of Peru, running inland of Callao, having total length of 258 miles, and rising to maximum elevation of 15,806 ft; bridges on main line; history of Verrugas bridges; tunnels in line; motive power and rolling stock. Bibliography.

ROADS AND STREETS

AIRPORT RUNWAYS. Paving Army Air Base Runways. *Western Construction News*, vol. 15, no. 11, Nov. 1940, pp. 365–367. Equipment and methods used in mixing and placing of 300,000 sq yd of concrete for runways of Hill Field near Ogden, Utah; paving design; paving operations and sequence; expansion joint arrangement.

AIRPORT RUNWAYS, DESIGN. Construction Design Chart—LVIII—Concrete Airport Runways, J. R. Griffith. *Western Construction News*, vol. 15, no. 10, Oct. 1940, p. 351. Construction of alinement chart for solution of formula for determining interior thickness of slabs for concrete airport runways; numerical examples.

AIRPORT RUNWAYS, WASHINGTON, D.C. Runways for Washington National Airport. *Eng. News-Rec.*, vol. 125, no. 21, Nov. 21, 1940, pp. 678–682. Method of stabilizing dredged sand and gravel in runways of National Airport at Washington, D.C., by use of small amount of soil binder and intensive mixing to make cementless soil-concrete base 9 in. thick; construction of 2-in. first course and 1½-in. top course of hot-mixed hot-laid asphaltic concrete, of same dredged material, using soft asphalts mixed at lower-than-usual temperatures to prevent cracking and undue oxidation; costs.

AIRPORTS, MILITARY. Building Bases for Our Air Forces. *Eng. News-Rec.*, vol. 125, no. 17, Oct. 24, 1940, pp. 544–555. Review of current air base planning and construction in United States; preparing air-field site; landing field drainage practice; air-base runway paving; building at air bases; utilities to serve air bases; major contracts for construction work at air bases.

ASPHALT. Improved Surface Texture for Asphalt Roads, C. E. Beland. *Roads & Bridges*, vol. 78, no. 11, Nov. 1940, pp. 24, 89–90, 92, and 94. Discussion of advantages of bituminous surfaces; early bituminous construction; road-mix disadvantages; advantages of plant mixes; present-day design of bituminous surfacings; qualities of constituents; repairs and retreatment. Before Can. Good Roads Assn.

CONCRETE. Concrete Pavements as Built in Province of Quebec, D. O. Robinson. *Roads & Bridges*, vol. 78, no. 10, Oct. 1940, pp. 22–23 and 86. Review of current practice of Department of Roads of Province of Quebec in construction of concrete highways, featuring stone or gravel cushions; mix specifications; curing with paper.

CONSTRUCTION. Cement-Treated Base Run Through Mixer. *Western Construction News*, vol. 15, no. 11, Nov. 1940, pp. 368–369. Report and construction of asphalt-surfaced highway near Red Bluff, Calif., featuring cement-treated crusher run base with 2¼ sacks of cement per cubic yard added to pit material; plant set-up; placing of base; tests.

CONSTRUCTION. Light Weight Soils Used in Heavy Idaho Fill, J. A. West. *Roads & Streets*, vol. 83, no. 10, Oct. 1940, pp. 48, 50, 52, 54, 56, and 58. Design and earth work construction of new roads, 3–6 miles long, north of Boise, Idaho; performance of equipment used; soil testing; control of light-weight soil embankments.

CONSTRUCTION. Terracing of Deep Cuts. *Roads & Bridges*, vol. 78, no. 9, Sept. 1940, pp. 22 and 62. Preventing disintegration of highway banks by terracing in connection with 740,000 cu yd earth-moving job on highway realinement, starting along foot of precipitous bluffs of Missouri River and cutting through bluffs and deep water-worn gullies for 3.94 miles to Magnolia, Iowa; largest cuts have depths of 84 ft, 62 ft, and 36 ft.

CONSTRUCTION. Variable Construction Methods on Twelve Mile Project, V. J. Brown. *Roads & Streets*, vol. 83, no. 10, Oct. 1940, pp. 29–37. Construction methods and equipment used in relocation of about 12 miles of Pacific Highway, U.S. 99, North of Vancouver, Washington; hydraulic grading, "high line" cable way, foundation settlement; cost data.

CONSTRUCTION. Vast Quebec Area Opened Up by New Highway, A. Bergeron. *Roads & Bridges*, vol. 78, no. 10, Oct. 1940, pp. 24–25 and 112. Construction of recently completed Quebec highway between Senneterre and Mont Laurier, 348 miles long; reconnaissance work; clearing operations; difficulties encountered; traffic facilities.

DESIGN. Method for Designing Non-Rigid Pavements for Highways and Airport Runways, A. T. Goldbeck. *Crushed Stone J.*, vol. 15, no. 4, Aug.–Oct. 1940, pp. 3–13. Method of design described will enable practical highway engineer to determine thickness of non-rigid road surfacing required to safely, yet economically, support given wheel load; method is founded on tests and is simple to apply.

DESIGN. Putting Planning Survey to Work, J. E. Furlong. *Better Roads*, vol. 10, no. 8, Aug. 1940, pp. 23–24 and 31–32. General discussion of application of state-wide highway planning surveys to development of rational street-and-highway safety program.

ELEVATED. Elevated Highways Versus Depressed Highways. *Am. City*, vol. 55, no. 10, Oct. 1940, pp. 61–62. Excerpts from Report of Committee on Elevated Highways of American Road Builders' Association; depressed highways and utilities; elevated highway costs; super-highway costs per linear foot.

EXPRESSWAYS, CANADA. Trans-Island Boulevard, Quebec's First Dual-Type Highway. *Roads & Bridges*, vol. 78, no. 10, Oct. 1940, p. 21. Brief description of new 4-lane expressway for Trans-Island Boulevard, running westward from city of Montreal across Island of Montreal and linking with present main highways to Toronto and Ottawa.

GRAVEL. Tar Bound Gravel Mix for Road Surfacing, C. L. Hanson. *Eng. & Contract Rec.*, vol. 53, no. 27, July 3, 1940, pp. 15–16 and 32. Inspection of tar-bound gravel-mix road, Kane County, Ill., built at cost of $5,000 per mile, showing but little wear after 2-year operation.

HIGHWAY ACCIDENT PREVENTION. Rural Walks Save Pedestrian Lives. *Better Roads*, vol. 10, no. 8, Aug. 1940, pp. 23–25. Review of experience of several state highway departments, indicating that walkways along rural highways increase safety of pedestrians.

HIGHWAY SYSTEMS, ALABAMA. Efficient Organization and Good Management Feature Jefferson County Highway Work. *Pub. Works*, vol. 71, no. 7, July 1940, pp. 14–16. Organization and planning for efficient and economical construction and maintenance of 1,500 miles of county roads in 1,200 sq miles of mountainous area in Alabama, containing population of 500,000; operating costs of equipment.

HIGHWAY SYSTEMS, NEW ZEALAND. Development of Main Highways of New Zealand, G. W. Albertson. *New Zealand Instn. Engrs.—Proc.*, vol. 26, 1939–1940, pp. 189–228. Review of development of Main Highways System in New Zealand; all-weather routes; bridge renewal program; improvements to alinement and grades; paving; costs of motor-vehicle operation; cost of truck operation; saving due to surface conditions; effect of improved alinement; transition curves; roadside beautification; service life of pavements.

HIGHWAY SYSTEMS, ONTARIO. Highways of Tomorrow, R. M. Smith. *Roads & Bridges*, vol. 78, no. 11, Nov. 1940, pp. 44, 76, and 78; (discussion) 52 and 55. Deputy Minister of Highways for Ontario discusses projected development of highway system of Ontario; increase in mileage of superhighways; grade separation; toll roads; private right of way; opportunities for engineer; restrictions on superhighways. Before Can. Good Roads Assn.

HIGHWAY SYSTEMS, ONTARIO. Queen Elizabeth Way: Canadian Super-Road. *Better Roads*, vol. 10, no. 11, Nov. 1940, pp. 20–21. Brief illustrated description of Toronto-Hamilton-Fort Erie project as outstanding example of modern main road design.

HIGHWAY SYSTEMS, QUEBEC. Planning Quebec Highways for Future Traffic Needs, E. Gohier. *Eng. & Contract. Rec.*, vol. 53, nos. 25 and 26, June 19, 1940, pp. 30–32, 76, and 78; and June 26, pp. 10–13. General discussion of plan for development of highway system of Quebec, with special reference to selection of types of highways.

HIGHWAY SYSTEMS AND DEFENSE. Highways and National Defense, T. H. MacDonald. *Am. Highways*, vol. 19, no. 4, Oct. 1940, pp. 11–14. Comments on German systems of superhighways; recommended practice for development of highway system of United States for national defense.

INTERSECTIONS. Engineering Approach to Design of Highway Intersections, J. Barnett. *Pub. Works*, vol. 71, no. 8, Aug. 1940, pp. 22–24 and 26–27. Basic data on intersection design; minimum designs for edge of pavement; design of median strips at intersections; oblique-angle intersections; separate turning lanes; flared intersections; islands and channels; sight distance at intersections.

MAINTENANCE AND REPAIR. First Aid Repairs to Roads and Bridges, J. D. Bolton. *Surveyor*, vol. 98, no. 2542, Oct. 11, 1940, pp. 171–172. Review of British war-time practice in maintenance and repair of roads and highway bridges; organization of repair work.

MAINTENANCE AND REPAIR. Sub-Grade Treatment by Mud-Jacking and Filling, P. J. Kunzer. *Roads & Streets*, vol. 83, no. 11, Nov. 1940, pp. 37–42. Study of causes and effects of "pumping" at pavement joints; methods and equipment used by Illinois State Highway Department to stop "pumping" action and correct damage done; gravel subgrade as preventive; method of treatment; raising and tightening of loose slabs and sealing voids under slab by forcing mud-mixture with aid of compressed air.

MATERIALS, BITUMINOUS. Bituminous Mixes Used in Oregon Maintenance Work, N. M. Finkbiner. *Western Construction News*, vol. 15, no. 9, Sept. 1940, p. 311–312. Analysis and characteristics of five bituminous maintenance mixes for patching plants, developed by Oregon State Highway Commission.

NATIONAL DEFENSE. Shaping Our Highway Program for National Defense, A. W. Brandt. *Am. Highways*, vol. 19, no. 4, Oct. 1940, pp. 15–19. Discussion of highway transportation systems in modern warfare; suggestions for United States highway development in program of national defense.

NEW YORK. New York Builds Mountain Highway to By-pass Old Storm King Road. *Eng. News-Rec.*, vol. 125, no. 13, Sept. 26, 1940, pp. 415–417. Design and construction of new dual highway through mountains back of West Point Military Reservation, N.Y., as part of program to improve alinement and eliminate narrow, winding sections of main highway on west side of Hudson River between Bear Mountain Park and Cornwall; roadway design; blended cements used; premolded expansion joints.

NEW YORK CITY. Solving Difficult Location Problems in New York City's East River Drive, L. C. Hammond. *Pub. Works*, vol. 71, no. 7, July 1940, pp. 10–11. Notes on location problems of 6-lane divided highway along eastern waterfront of Manhattan Island, known as East River Drive, with special reference to 2-deck sections.

PENNSYLVANIA. Speed in Paving Methods as Exemplified by Pennsylvania Turnpike, S. W. Marshall. *Roads & Bridges*, vol. 78, no. 9, Sept. 1940, pp. 23–26 and 66. Methods and equipment used on Pennsylvania Turnpike in construction of 109.5 miles of portland cement concrete pavement, 48 ft wide and of uniform 9-in. thickness, in 136 working days; plant set-up; furnishing mixing water; concrete control; material deliveries; cost of paving.

RIGHT-OF-WAY. Marginal Land Acquisition for Highways, H. R. Briggs. *Pub. Roads*, vol. 21, no. 6, Aug. 1940, pp. 105–118. Discussion of problems involved in acquisition of excess land incidental to highway development; laws sanctioning condemnation of land remnants; constitutional amendments extending power of eminent domain; city practices in condemning excess land; state practice regarding acquisition of excess lands; summary of reported costs and recoveries in selected recoupment enterprises. Bibliography.

RIGHT OF WAY. Wider Rights of Way Will Solve Many Highway Problems, W. A. Clarke. *Roads & Bridges*, vol. 78, no. 11, Nov. 1940, pp. 19 and 84–86. Discussion of trend towards wider rights of way in highways; balanced design; provision for parking; standardized entrances; airplane landing strips; wider shoulders; guard rails. Before Can. Good Roads Assn.

ROAD MACHINERY, CRUSHERS. Portable Electric Crusher for Highway Surfacing Job. *Western Construction News*, vol. 15, no. 9, Sept. 1940, pp. 314–315. Description of all-electric, portable crushing and screening plant set up near Buellton, Calif., consisting of two trailers mounting crushers and screens, all motor-driven from Diesel electric generator on third trailer.

ROADS AND STREETS. Pavement Sealing Successfully checked, O. L. Moore. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, pp. 471–474. Results of study of concrete scaling due to use of chlorides to clear icy roads, indicating that scaling could be prevented by grinding rosin product into cement; occurrence of scaling; effect of cement on scaling of concrete surfaces.

SNOW CONTROL. 60 Miles of Roadside Snow Hedges. *Better Roads*, vol. 10, no. 9, Sept. 1940, pp. 27–28. Discussion of principles and economics of snow-drift control by means of roadside snow hedges, based on experience of three central Wisconsin counties.

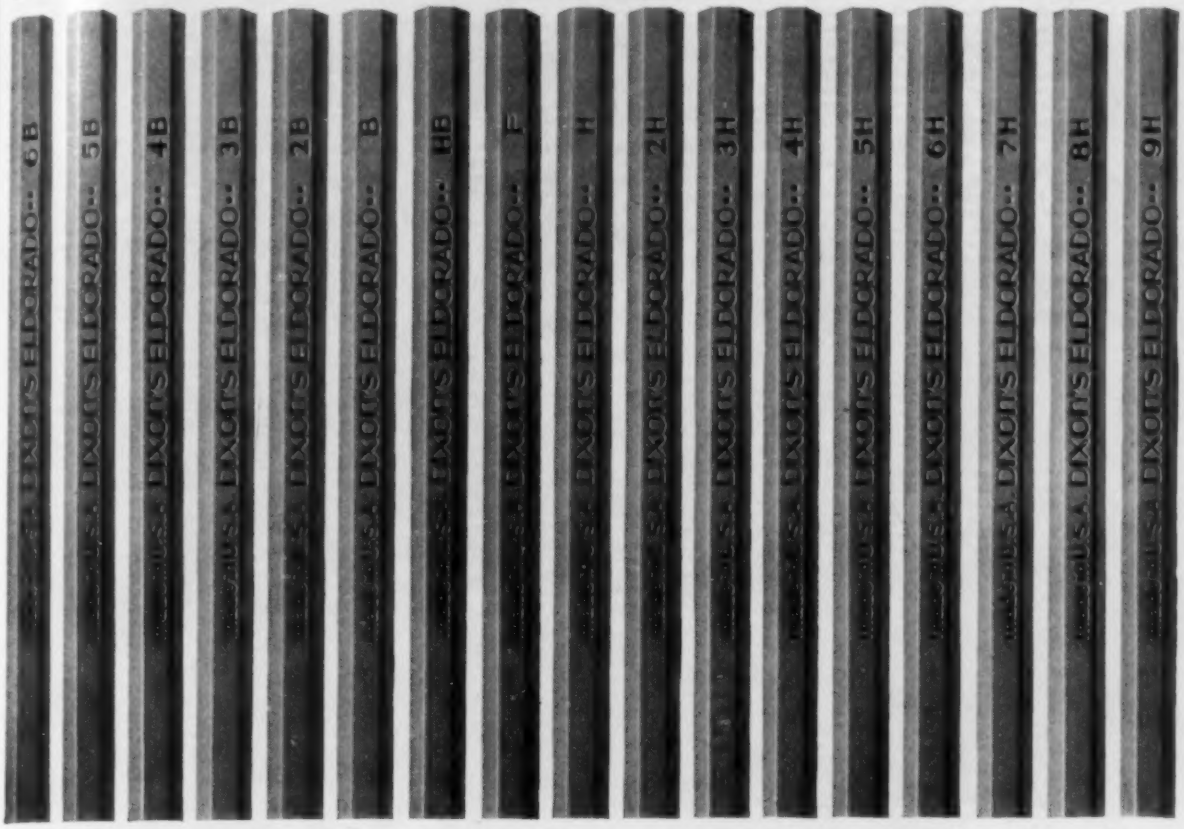
STABILIZATION. Co-operative Study of Road Stabilization. *Roads & Bridges*, vol. 78, no. 11, Nov. 1940, pp. 22–23, 72, and 74. Report of All-Canadian Committee on Road Stabilization to Canadian Good Roads Association; various means of developing stabilized road; design of base courses.

TESTING. Highway Investigation by Means of Induced Vibrations, R. K. Bernhard. *Pa. State College—Eng. Experiment Station—Bul. 49*, vol. 33, no. 49, Oct. 2, 1939, 28 pp. 50 cents. Discussion of methods of dynamic testing of foundation subsoils and pavement slabs by application of artificial vibration, excited by centrifugal forces resulting from rotation of eccentrically supported masses. Bibliography.

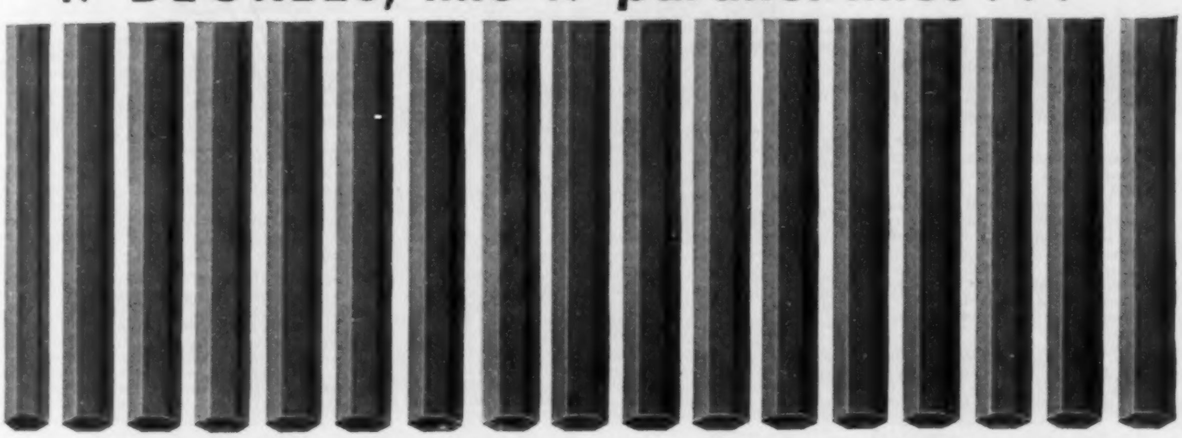
SEWERAGE AND SEWAGE DISPOSAL

CHLORINATION. Use of Chlorine in Sewage Treatment. *Sewage Works Eng. & Mun. Sanitation*, vol. 11, no. 11, Nov. 1940, pp. 560–570. Practical discussion, by sewage works superintendents, of equipment and methods used for chlorinating sewage; size of chlorine containers; safety precautions practiced in handling and applying chlorine; points of application; results of chlorination; costs.

TYPHONITE ELDORADO PENCILS



17 DEGREES, *like 17 parallel lines . . .*



. . . THEY NEVER MEET!

Never will you pick up a Dixon's *Typhonite* Eldorado stamped "2H" and find that it is a "3H" or an "H" in performance. Like parallel lines, the 17 degrees of *Typhonite* Eldorado never meet. Such uniformity is possible only because Eldorado leads are made from *Typhonite* particles that are minute twins. Each particle is minute in size, and each is the same size.

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But uniformity is not all you should ask of a drawing pencil. Its lead must be strong and dense and smooth. Test *Typhonite* Eldorado for these qualities. And make the tests tough.

To test for strength, sharpen a *Typhonite* Eldorado to the finest point. To convince yourself that Dixon's *Typhonite* Eldorado pencils are smooth and opaque even in the hardest degrees, test the H degrees. Make these tests and know that there is no other pencil like Dixon's *Typhonite* Eldorado.

Your dealer carries Dixon's *Typhonite* Eldorado.

Pencil Sales Department 38-J2

JOSEPH DIXON CRUCIBLE COMPANY, JERSEY CITY, N. J.

DISPOSAL, LOS ANGELES, CALIF. Sewage Situation of City of Los Angeles, F. Thomas. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 879–893. Review of trunk sewerage and sewage disposal situation of City of Los Angeles and its tributary environs; history of development of sewage disposal in Los Angeles, Calif., and its suburbs; population growth of Los Angeles; beach and ocean conditions; sewage flow of Los Angeles and other communities tributary to Hyperion plant; character of sewage; physical condition of lines and works; issues of present situation.

DISPOSAL PLANTS, LIBERTY, N.Y. Biofiltration Comes East. *Eng. News-Rec.*, vol. 125, no. 13, Sept. 26, 1940, pp. 402–404. Design, construction, and operation of new 1-mgd sewage disposal plant of Liberty, N.Y., featuring biofiltration process consisting of rapid filtration through relatively shallow beds of crushed stone, part of filtered sewage returning to incoming flow for recirculation.

FILTERS, TRICKLING. Die Bodenlueftung bei biologischen Tropfkoerpern, K. Imhoff. *Gesundheits-Ingenieur*, vol. 63, no. 21, May 25, 1940, pp. 262–265. Review of principles of design of trickling filters, with special reference to provisions for their aeration; examples from European and American practice.

FILTERS, TRICKLING. Design Details for Trickling Filter Underdrains and Ventilation, R. W. Andrews. *Pub. Works*, vol. 71, no. 8, Aug. 1940, pp. 17–20. Discussion of minor details in design of underdrainage systems and ventilation for trickling filters, to obtain uninterrupted and straight lines of drains without angles or connections, and for passing underdrains under or around center pier when rotary distributor is used; supporting distributing pipe; center pier details; arrangement for drainage; sewer infitration at Fort Worth, Tex.

HISTORY. Sewerage in Ancient and Medieval Times, H. F. Gray. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 939–946. Historical notes on sewerage and sewage disposal in Asia and Europe during ancient and medieval times, also during nineteenth century.

IRRIGATION. Land Preparation for Sewage Irrigation, S. S. Searle. *Commonwealth Engr.*, vol. 28, no. 1, Aug. 1, 1940, pp. 16–19. Preparation of 22,600 acres of Metropolitan Farm at Melbourne, Australia, for sewage irrigation, involving following operations: Subsoiling, rough grading and leveling, formation of check banks, final grading, sowing, construction of distribution channels and drains.

PLANTS, COVINA, CALIF. Covina, California, Sewage Treatment Plant, A. H. Koebig, Jr. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 895–902 (discussion), 903–906. Design, construction, and operation of new 0.5-mgd sewage disposal plant of Covina, Calif., using both biological and chemical treatment processes; gas production.

PLANTS, EQUIPMENT. Rotary Blowers in Activated Sludge Plants, D. L. Dowling. *Water Works & Sewerage*, vol. 87, no. 9, Sept. 1940, pp. 440–447. History of development and applications of rotary blowers, particularly for aeration and other processes in operation of activated sludge in sewage treatment plants; operating characteristics of rotary type blowers; volume pressure relationships; temperature effects; dual compartment blowers; blower putput control; representative installations in United States. Before Am. Soc. Mech. Engrs.

PLANTS, OPERATION. Operating Experiences in Sewage Treatment at Buffalo, N.Y., C. R. Velzy, J.W. Johnson, and G.E. Symons. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 907–918. Review of operating experiences and problems of sewage disposal system of Buffalo, N.Y.; pre-pumping problems; pumping experiences; screening experiences; analysis of grit samples; sewage chlorination; sedimentation; sludge tanks; sieve characteristics of dried sludge and ash. Bibliography.

PLANTS, OPERATION. Problems in Garbage-Sewage Treatment. *Eng. News-Rec.*, vol. 125, no. 13, Sept. 26, 1940, pp. 407–409. Results of 14 months of operation of Lansing, Mich., 9-mgd combination treatment plant for handling ground garbage and sewage sludge; clogging of sludge transfer pipes; accelerated digestion; cost data.

PLANTS, SPRINGFIELD, MASS. New England's Newest Sewage Works, E. J. Cleary. *Eng. News-Rec.*, vol. 125, no. 13, Sept. 26, 1940, pp. 396–401. Description of two new sewage disposal plants of Springfield, Mass., having capacity of 30 mgd and 3 mgd, respectively, larger one including incinerator having capacity of 10.5 tons per 24 hours.

PLANTS, WEBSTER CITY, IOWA. Dual Units Solve Resort Sewage Problem, A. D. Swisher. *Eng. News-Rec.*, vol. 125, no. 13, Sept. 26, 1940, pp. 405–406. Description of Webster City, Iowa, activated sludge disposal plant with dual treatment units for winter and summer operation; for handling sewage from resort, whose population varies from 3,000 to 30,000, featuring combination aeration-settling tank unit; advantages of dual unit.

SEWERS, DECATUR, ILL. Revamping 50-year Old Sewer System, W. D. P. Warren. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, pp. 475–476. Revamping of old sewer system of Decatur, Ill., including construction of 5 miles of new sewers and relining of 2.8 miles of 20-year-old sewer pipe; new sewers ranged in size from 15-in. (vitrified pipe) and 24-in. (concrete) to circular concrete sewer with inside diam. of 108 in. and concrete arch 10 ft $10^1/_2$ in. by 13 ft $7^1/_4$ in. in section; laying pipe in tunnel; concrete tests.

SEWERS, MAINTENANCE AND REPAIR. Maintenance of Sanitary Sewers in San Diego, California, B. D. Phelps. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 982–985, (discussion) 985–987. Review of sewer maintenance practice in San Diego, Calif., with special reference to anchorage of outfall, operation of settling tanks and pumping plants; cleaning of sewers, etc.

SEWERS, MAINTENANCE AND REPAIR. Methods and Problems of Sewer Maintenance, R. F. Brown. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 969–977, (discussion) 977–982. Discussion of routine sewer maintenance work in Los Angeles, Calif.; field crews and trucks; cleaning and rodding; construction and repairs; manhole covers; sewer flushing; gas survey; sewer ventilation. Bibliography.

TANKS, CONCRETE. Forming and Concreting Sewage Tanks. *Eng. News-Rec.*, vol. 125, no. 15, Oct. 10, 1940, pp. 461–463. Design and construction of reinforced concrete sewage tanks of Jamaica Bay Sewage Disposal Plant, New York, including aeration tanks covering area 250 by 320 ft; 12 sludge digestion tanks, 80 ft in diameter and 34 ft high; 2 sludge thickening tanks, 55 ft in diameter; and 8 final tanks, 120 ft in diameter and about 15 ft high; planning, detailing, and fabrication of forms; light-weight materials generally used in small units.

WATER POLLUTION, CALIFORNIA. Pollution Control Work of California State Division of Fish and Game, P. A. Shaw. *Sewage Works J.*, vol. 12, no. 5, Sept. 1940, pp. 947–953. Review of work of California State Division of Fish and Game in controlling water pollution; enforcement of federal and state laws; injunction or private damage suits; control of waste disposal; food and beverage wastes. Bibliography.

WATER POLLUTION, NIAGARA RIVER, N.Y. Bacterial Pollution of Niagara River—2, G. R. Symons and R. W. Simpson. *Am. Water Works Assn.—J.*, vol. 32, no. 9, Sept. 1940, pp. 1529–1546. Results of Buffalo Sewer Authority surveys to determine improvements in conditions of river following sewage treatment and disinfection; bacterial data; sewage treatment operating data; bacterial content of intake water at Niagara Falls. Bibliography. See also ***Engineering Index 1939***, p. 1266.

STREET CLEANING AND REFUSE DISPOSAL

AIRPORTS, SNOW REMOVAL. Snow Handling Methods on Canadian Airports. *Roads & Bridges*, vol. 78, no. 10, Oct. 1940, pp. 30–32. Features of equipment used on Canadian airport for compaction and removal of snow; use of blowers to prevent runway build-up; snow loaders.

STRUCTURAL ENGINEERING

ARCHES, CONCRETE. Plain and Reinforced Concrete Arches, C. S. Whitney. *Am. Concrete Inst.—J*, vol. 12, no. 1, Sept. 1940, pp. 1–26. Suggested specifications for reinforced concrete arch design; effect of shrinkage and plastic flow, results of investigations; recommendations as to calculations of moments and thrusts due to loading and volume changes; new method for design of arch rib based on ultimate strength formulas; factor of safety for members subjected to direct load and flexure. Bibliography.

ROOFS, ARCH. Stabilising Effect of Passive Resistance on Underground Arches, J. D. W. Ball. *Engineer*, vol. 170, no. 4415, Aug. 23, 1940, pp. 119–120. Analysis of stresses in brick arched roof, such as are used in many underground shelters and storage chambers; experience shows that best results are obtained by aiming at symmetry, that is, equally inclined reactions at each abutment.

STRESSES. Nomographic Solution of Stress Problem, D. B. Thomas. *Engineer*, vol. 170, no. 4415, Aug. 23, 1940, p. 120. Complete determination of stress involves determination of magnitude and direction of principal stresses; convenient method of solving equations involved given.

TRUSSES, WOODEN. Job Yard Builds 7,200 Roof Trusses with Production Line Methods. *Construction Methods*, vol. 22, no. 10, Oct. 1940, pp. 52–53, 98, and 100. Methods and equipment used in fabrication of 7,200 wooden roof trusses for 27-ft spans of Sunnydale Housing Project at San Francisco where 772 family units are being constructed in 400 days; roof trusses are set on 2-ft centers, with nailing strips attached to under side.

SURVEYING

MEASURING CURVES. Device for Measuring Degree of Curvature, J. S. Burch and W. Thomas. *Roads & Streets*, vol. 83, no. 10, Oct. 1940, pp. 60 and 62. Description of North Carolina type curvemeter developed for quick measurements of highway curves in field, costing about $85; performance test of device.

TUNNELS

CONCRETE LINING. Tunnel Lining Methods for Concrete Compared, L. H. Tuthill. *Am. Concrete Inst.—J.*, vol. 12, no. 1, Sept. 1940, pp. 29–47. Study of current experience with comparative merits of various methods for lining tunnels with concrete, including consideration of equipment as well as methods; leakage, shrinkage, and cracking; contraction joints for concrete lining of tunnels, including water supply tunnels; equipment for placing concrete in tunnel linings; concrete pumps; lining of tunnel invert.

MINES AND MINING. Speedy Tunneling Maintained on 6-Mile Carlton Mine Drainage Bore. *Construction Methods*, vol. 22, no. 9, Sept. 1940, pp. 65–67 and 101–102. Building of 32,000-ft long Carlton tunnel, now under construction, to drain gold-bearing ore bodies in vicinity of Cripple Creek, Colo., and to extend mining operations to depths now prohibited by excessive inflows of ground water; cross section of tunnel is 10 ft wide and 11 ft high; removal of blasted rock.

VENTILATION. Ventilating Pennsylvania's Super-Highway. *Heating & Vent.*, vol. 37, no. 10, Oct. 1940, pp. 9–13. Seven tunnels of Pennsylvania Turnpike have total length of nearly 7 miles and are provided with automatic control of carbon monoxide; descriptions of ventilation of tunnels and heating and ventilating of service buildings; floor plan of midway main building on Pennsylvania Turnpike is presented showing heating details.

WATER SUPPLY, NEW YORK. Delaware Aqueduct—V and VI. *Eng. News-Rec.*, vol. 125, nos. 3 and 9, July 18, 1940, pp. 109–113, and Aug. 29, pp. 288–293. Controlling flow; driving 85 miles of tunnel.

WATER PIPE LINES

JOINTS. Unusual Joint Features on Concrete Lined Steel Pipe, J. A. Wade and H. P. Wenrick. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 344–345. Use of special type joint in construction of 6-mile industrial water supply line in Contra Costa County, Calif., featuring rubber ring seal which is circular in section until joint is made up by jacking spigot end into bell; rubber is compressed into section indicated, and joint is completed by applying cement plaster to both sides.

WATER RESOURCES

UNDERGROUND, OKLAHOMA. Ground Water in Oklahoma Panhandle, S. L. Schoff. *Economic Geology*, vol. 35, no. 4, June–July 1940, pp. 534–545. Geological study of underground water supplies of part of Oklahoma; water table; areas of moderately shallow ground water; unfavorable areas; observation wells; effect of drought on water table.

WATER TREATMENT

FILTRATION PLANTS. Concentrator for Solids in Filter Effluent, H. Weigand. *Am. Water Works Assn.—J.*, vol. 32, no. 9, Sept. 1940, p. 1528. Description of device by which filter performance may be checked and best method of washing filters determined.

FILTRATION PLANTS, RALEIGH, N.C. New Filter Plant and Pumping Station at Raleigh, N.C., W. C. Olsen. *Water Works & Sewerage*, vol. 87, no. 10, Oct. 1940, pp. 449–460. History of water works of Raleigh, N.C., since 1885; description of new 8-mgd water filtration plant and pumping station, with special reference to filter effluent, and waste conduits; mixing and flocculation units; raw water flow control; control of filtered water flow; high duty pumping equipment; laboratory; chemical feed machines; heating and plumbing system; architectural treatment.

LA VERNE, CALIF. Filtration Plant for Colorado Aqueduct System. *Western Construction News*, vol. 15, no. 10, Oct. 1940, pp. 333–335. Design and construction of Colorado River aqueduct water treatment plant at La Verne, Calif., having ultimate capacity of 400 mgd; stages of construction progress.

WATER WORKS ENGINEERING

NATIONAL DEFENSE. Water Supply in Time of War, F. F. Longley. *Water Works Eng.*, vol. 93, no. 22, Oct. 23, 1940, pp. 1344–1348 and 1367–1368. Article based on paper before New England Water Works Association, discussing war-time operation of water works in established cities and towns; vulnerable points; water supply in camps; army water supply agencies; water supply in combatant zones; water supply army troops; control of quality of army water supplies; conditions affecting army water supply work; portable water unit.

PEEKSKILL, N.Y. New Reservoir for Peekskill, G. P. Wood. *Water Works Eng.*, vol. 93, no. 20, Sept. 25, 1940, pp. 1228–1231. Description of recent additions to water works of Peekskill, N.Y., including low concrete dam 325 ft long, and core wall earth dike 725 ft long; cost data on construction of dam.

Engineers may design . . .

BUT FEAR BLOCKS THE WAY

BIGVILLE — and many another thriving community, for that matter — has it's kindly old MR. YES, BUT among the City Fathers or engineers. Let someone offer a new and better way to do a thing; advocate a progressive idea, and he's in his glory. For squelching things he uses a very neat technique. No matter how clean cut, far-reaching and advantageous a move might be, you can count upon him to block it, by parading a lot of fears that start with "YES, BUT".

No City Father, Commissioner or Engineer need fear the adoption of designs or equipment for the sanitary disposal of municipal solid wastes, including sewage sludge, screenings, grit, garbage, rubbish or industrial wastes offered by this organization. For "Incineration Headquarters" maintains an integrated program of laboratory and field research. The co-ordination of laboratory research, plant design, operation and field experience makes it possible for this organization to offer only tried and proven equipment of the most advanced design. There's no reason why you and your community should accept an outmoded practice, just because that's the way they do it over in So and So. Progress has been made in the science of incineration as in road building, as in lighting, as in municipal management itself. What's good enough for some other place may not meet your local needs at all.

So if your community has a waste disposal problem, get in touch with "Incineration Headquarters". You will secure the benefit of the knowledge, experience, resources and cooperation of the best equipped organization in America to solve these problems.

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60 WALL TOWER BLDG., NEW YORK, N. Y. **NERCO** *UNIVERSITY TOWER BLDG., MONTREAL, P. Q.*

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

New Nickel Alloy

An addition to the group of high nickel alloys, known as "KR" Monel, has been announced by The International Nickel Co., Inc. It has high strength, can be fabricated in automatic screw machinery, resists corrosion, and can be heat treated after fabrication to provide an extra measure of strength and hardness. The alloy is being produced in rod and wire forms only.

"KR" Monel represents the culmination of a development to make available a metal which would offer machining characteristics together with physical properties similar to "K" Monel. Like "K" Monel, "KR" Monel is non-magnetic. Being a non-ferrous alloy with the same composition as "K" Monel and Monel, it provides the characteristic corrosion resistance of these materials. It derives its free machining qualities from special thermal treatment at the mill.

Light Centrifugal Pump

Chain Belt Co. of Milwaukee, Wis., announces the manufacture of "Rex Junior," a new, light-weight, 3000 gal per hr centrifugal pump weighing only 54 lbs.

This $1^1/_2$ in. pump contains all the engineering features of the standard line of Rex centrifugal pumps, including the patented Rex "peeler," a device that actually peels the air from the whirling impeller and thus speeds up the prime.

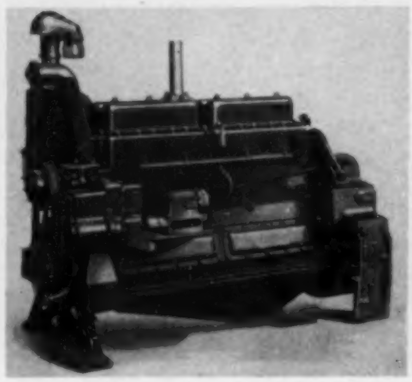
It has a large semi-steel recirculating water chamber equipped with an aluminum cap to save weight and is powered by a dependable, easy starting single cylinder, air cooled engine of $^3/_4$ to one hp. The engine is equipped with an automatic governor that speeds up the motor when the pump catches its prime and starts to lift water. This eliminates strain on the power unit at low speeds.

The overall dimensions are $15^1/_4$ in. long by $11^3/_4$ in. wide by $15^3/_4$ in. high.

Natural Gas Engines

Three models of heavy-duty natural gas engines have been announced by Caterpillar Tractor Co. of Peoria, Ill.

The engines are built in two cylinder sizes. The Model 4600G is a six cylinder unit and the 4400G is a four. Both of these engines have a bore of $4^3/_4$ in. and a $5^1/_2$ in. stroke and they develop 74 and 48 hp, respectively, at 1600 maximum governed rpm. A small four, the Model 3400G with a bore and stroke of $3^3/_4$ in. × 5 in. develops 34 hp at 1650 rpm.



The three valve-in-head engines are designed for heavy-duty work with a minimum of maintenance. They are equipped with heat resistant alloy valve seat inserts, and superfinished crankshafts with "Hi-Electro" hardened journals. Main bearing surface on the 4600G is 118 sq in.; on the 4400G, 89.5 sq in.; and on the 3400G, 80.3 sq in.

A combination gas-gasoline carburetor is standard equipment, and though the engine will satisfactorily burn gasoline for short periods for starting purposes, the fuel system is set for the most efficient combustion of natural gas. The system includes a filter to clean the gas with a regulator to handle gas pressures as high as 150 lbs at the supply, and a manually operated manifold heat control.

All three engines are available fan to flywheel, or as a complete power unit with enclosed clutch and radiator.

Electric sets, incorporating each of the engines coupled to a self-regulating generator, have also been announced.

Transparent Feeder

With the first of the year, Proportioneers, Inc., established "See-Thru" construction as standard on practically all of their machines. "See-Thru" incorporates a transparent molded plastic reagent end on the machines, enabling operators to see the pumps function.

Details of this equipment, with drawings and photographs of applications suiting different conditions, are available from Proportioneers, Inc., 14 Codding St., Providence, R.I.

Literature Available

ALLOY STEEL—Mayari R, the low-alloy, high strength, corrosion-resisting steel of Bethlehem Steel Co., Bethlehem, Penna., is covered in the 32 pages of Catalog 156.

CONCRETE GRANDSTANDS—This 32-page booklet is devoted primarily to information needed by the designer of small and medium size concrete grandstands, such as location, size, layout, facilities, and details of design and construction. General information on methods of financing, drawings of typical designs and details, and photographs of existing grandstands are given. Portland Cement Association, 33 West Grand Ave., Chicago, Ill.

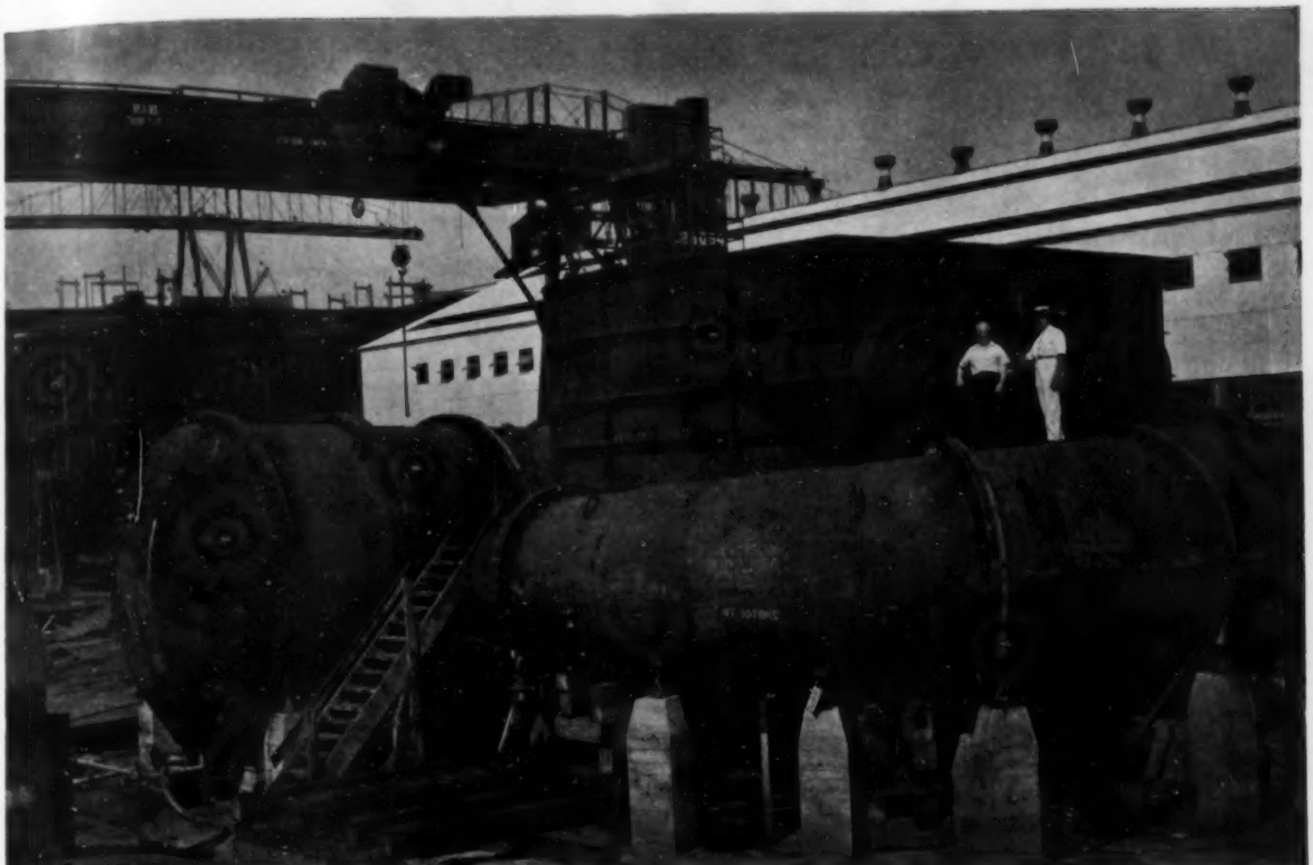
DIESEL TRACTOR—A catalog, printed in three colors, devoted entirely to the new 80 hp Diesel D7 tractor, has been issued by Caterpillar Tractor Co., Peoria, Ill. Cutaway pictures show cross sections of the engine and the tractor chassis, while the accompanying text gives a complete description of all working parts.

GAS CUTTING MACHINE—No. 10 Radiagraph bulletin just published by Air Reduction, 60 East 42nd St., New York, N.Y., discusses in detail this lightweight motor-driven gas cutting machine. The scope of the standard machine includes cutting straight lines of any length using a track; cutting circles from 3 to 85 in. in diameter; cutting arcs up to a radius of $42^1/_2$ in., and irregular outlines by manual operation to a limited degree. In any of these operations cuts can be made having either square or beveled edges. Features of construction are outlined in detail. An 8-page bulletin has also been published on the Airco No. 10 Planograph.

PUMPS AND PUMP PARTS—A new illustrated booklet containing comprehensive information on pumps and pump parts has been published by The International Nickel Co., Inc., 67 Wall St., New York. This 16-page folder, "Practical Pumping Problems and How They Are Solved," discusses in detail the uses of Monel, "K" Monel and "S" Monel for pump parts in applications where there is need for high resistance to corrosion, wear, pitting, or scoring. This includes different types of pumps, reciprocating, centrifugal, and rotary.

VALVE CONTROLS—A new folder describes the speed and ease of controlling the operation of all types of valves with Limitorque. Philadelphia Gear Works, Erie Ave. and G St., Philadelphia, Penna.

WINTER CONCRETING—"Get These Nine Advantages in Winter Concreting by Using Solvay Calcium Chloride," is a new folder just announced by the Solvay Sales Corporation, 40 Rector St., New York, N.Y. The nine separate advantages include lower concreting costs, quicker set, high early strength, greater final strength, extra cold weather protection, uniform curing, shorter protection period, less forms and equipment, increased density and hardness. Data taken from tests conducted by the National Bureau of Standards and the Portland Cement Association are referred to in proving the statements made.



150,000 HP Francis Turbine for Grand Coulee Project

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HYDRAULIC TURBINES

Francis and High Speed Runners
Butterfly Valves
Power Operated Rack Rakes
Gates and Gate Hoists
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Newport News Shipbuilding and Dry Dock Company
(Hydraulic Turbine Division)
Newport News, Virginia

Ludlow Announces Executive Changes

ALFRED W. THOMPSON was elected President, Treasurer, and General Manager of The Ludlow Valve Manufacturing Co., Inc., of Troy, N.Y., at a recent meeting of the Directors. Mr. Thompson was formerly Vice-President and General Manager.

He succeeds as President, Livingston W. Houston, who has been associated with the Company for twenty-two years and as President for the past eight years. Mr. Houston was elected Chairman of the Board and will continue in an active executive capacity in the management of the Company.

Robert Bischoff, formerly associated with the Koppers Company in a sales and engineering capacity, has been appointed Sales Manager.

New Airco Welding Rods

AN OUTSTANDING NEW high-test flux-coated bronze welding rod has recently been announced by Air Reduction. It is claimed to offer eight advantages for bronze welding operations:

1. Low fuming; 2. Applies faster; 3. Denser deposit; 4. Increased tensile strength; 5. Greater bond strength; 6. Increased hardness of deposit; 7. Improved ductility; 8. Time saving.

Each of these qualities contributes to the time saved when Airco high-test flux-coated bronze welding rods are used, it is said. The flux adheres splendidly in shipment and in use, and will not fall off when the rod is excessively bent. For full information write Air Reduction, 60 East 42d St., New York, N.Y.

New 1/2-Yard 15-B Added to Bucyrus-Erie Line

FOLLOWING A LONG-ESTABLISHED policy of designing and building excavators specifically for the capacity desired, Bucyrus-Erie announces the development of a wholly new 1/2 yd machine—the 15-B. Simplified front-end construction makes the new unit easily convertible in the field from shovel to dragline, crane or drag shovel. Standard power is a 54 hp gasoline engine with specially-designed carburetor and manifold. Both Diesel or electric power are also available.

All-welded booms for dragline, clamshell and crane service have been designed to give the 15-B maximum range and capacity per pound of weight. Field convertibility has been simplified by mounting crowd rope and drum on the shovel boom. To change dragline or crane to shovel, only the crowd-chain unit need be added. For shovel work, 15-B front-end design features the positive, independent twin rope crowd, and a single-rope retract. Boom and handle are of welded box-section construction with internal reinforcing. A heat-treated cast saddle block carries the inside handle which slides on the big combination roller and crowd-rope sheave.

Smooth swing has been built into the 15-B by the reduction of deadweight, and by the use of conical hook swing rollers operating in a double roller path case integral with the truck frame for strength. This design eliminates the center pintle and distributes lifting and swinging loads over a wide area. Sixteen in. treads provide an area of 21.5 sq ft for firm footing. Twenty and twenty-four in. treads are also available. For details write to Bucyrus-Erie Co., South Milwaukee, Wis.

Northwest Announces a New Truck Crane

THE NORTHWEST ENGINEERING COMPANY, exclusive builders of shovels, cranes and draglines announces that the Northwest Model 20 Crane is now available as a truck crane of 15 tons capacity. This model completes the Northwest truck crane line of four cranes ranging in capacity from $4^1/_2$ to 18 tons capacity.

The Model 20 is equipped with all the standard Northwest features. The "feather-touch" clutch control takes the fatigue out of operation, it is said; shifting the clutches through the power of the engine, yet retaining the feel of the load. Swing clutches on this new Model 20 Truck Crane are of the Northwest standard uniform pressure type.

The Model 20 can also be equipped with "Power up and Power down" boom hoist—an independent boom hoist functioning as its name implies in raising or lowering the boom, free or under load with power either booming up or down. A single lever is used to control the functions of boom hoisting, boom lowering and braking. An engine throttle control is also provided allowing the engine to be slowed down over a wide range.